UNITED
NATIONS

A

General Assembly

Distr.
GENERAL

A/AC.105/523
16 December 1992
ENGLISH
ORIGINAL: ENGLISH/FRENCH/SPANISH

COMMITTEE ON THE PEACEFUL USES OF
OUTER SPACE

INTERNATIONAL COOPERATION IN THE PEACEFUL USES OF OUTER SPACE - ACTIVITIES OF MEMBER STATES

Note by the Secretariat

1. The Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), in the report on the work of its sixth session (A/AC.105/513, annex II), made recommendations concerning the preparation of reports and studies by the Secretariat and the compilation of information from Member States.

2. The Working Group recommended, in paragraph 10 of its report, that in the light of the continued development and evolution of space activities, the Committee on the Peaceful Uses of Outer Space should request all States, particularly those with major space or space-related capabilities, to continue to inform the Secretary-General annually, as appropriate, about those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of the developing countries, in order to permit a better assessment of the present and future of such international cooperation by the Working Group at its next session.

3. The report of the Working Group was adopted by the Scientific and Technical Subcommittee at its twenty-ninth session (A/AC.105/513, para. 22), and the recommendations of the Working Group were endorsed by the Committee on the Peaceful Uses of Outer Space at its thirty-fifth session. 1/

4. The Secretary-General subsequently addressed a note verbale dated 31 August 1992 to all Member States, requesting them to communicate to the Secretariat, by 1 October 1992, the information requested in the above-mentioned recommendations.

5. The Secretary-General also drew the attention of Member States to the recommendation of the Committee contained in paragraph 148 of its report:

> "The Committee recommended that the Secretariat invite Member States to submit annual reports on their space activities. In addition to national and international space programmes, the reports could include information in response to requests from the Working Group of the Whole as well as information on spin-off benefits of space activities and other topics as requested by the Committee and its subsidiary bodies." 2/

6. In accordance with the recommendation of the Committee, the Secretary-General further suggested to Member States that information in response to those requests could be submitted in a single report on national space activities, with an indication of information that responded to specific requests from the Working Group in particular with regard to:

(a) Those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of the developing countries;

(b) Spin-off benefits of space activities;

(c) National and international research concerning the safety of nuclear-powered satellites;

(d) Studies conducted on the problem of the collision of nuclear power sources with space debris;

(e) National research on space debris.

7. The present document was prepared by the Secretariat on the basis of information on the first two items above, received from Member States as of 10 December 1992. Information received subsequent to that date will be included in addenda to the present document. Information received regarding the last three items will be presented in a separate document.

Notes

1/ Official Records of the General Assembly, Forty-sixth session, Supplement No. 20 (A/47/20), para. 29.

2/ Ibid., para. 148.

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AUSTRALIA

[Original: English]

INTRODUCTION

The Australian Government announced its space policy in 1986 and established the Australian Space Board to oversee the national space programme and to advise the Minister for Industry, Technology and Commerce. The objective of Australian space policy is to encourage greater involvement by Australian industry in space research-and-development activities and to promote development of commercially viable industries based on space technologies.

In September 1987, the Australian Space Office was formed within the Department of Industry, Technology and Commerce to manage the national space programme and to serve the Space Board. The Office is charged with responsibility for developing internationally competitive Australian industries and commercial enterprises based on space technology, and for the creation of an innovative research-and-development environment in which to foster industry participation.

Australian space policy combines elements of both industry policy and science and technology policy. Government industry policy is aimed at developing internationally competitive, innovative industries, integrating Australian industry more closely into the world economy and reducing industry's reliance upon direct government assistance and regulation. The Government's science and technology policy highlights the importance of science and technology for the generation of economic growth, the protection of the environment and responsible uses of Australia's natural resources; it specifically identified the central role of science and technology in achieving an internationally competitive Australian economy.

In 1990-1992, the activities of the Office mainly focused on the implementation of the Space Industry Development strategy, which provides the framework for the development of commercial space industry in Australia. The strategy is based upon the priority areas of:

- Satellite remote sensing;
- Satellite communications; and
- Space launch services.

The major thrust of the Strategy was the expansion of industry capability in the production and delivery of space-based goods and services. This capability was seen as essential to international recognition of Australia as a space-qualified nation, able to contribute to and benefit from scientific and commercial participation in overseas space programmes.

At an early stage, the Office became aware of a very substantial national requirement for space-based goods and services. Applications of space technology which deliver direct public benefits, as opposed to those which primarily serve industrial or commercial ends, have provided and will continue to provide much of the impetus for the growth and diversification of Australian space capability, and a range of significant social and economic benefits. Recognition of this led the Office to a fresh appraisal of the dimensions of the Strategy, which indicated a need for a broader interpretation of Australia's space requirements and expectations than those predicated primarily on industry development outcomes.

In June 1990, the Board gave expression to this broader strategic requirement, introducing the concept of a "Balanced National Space Programme". Driving this initiative was a recognition that industry development is but one objective amongst several, directed to national priorities, which a true national space programme should address.

Strategies for the future development of the space sector will therefore continue to address the requirements of and opportunities for industry, at the same time also focusing on opportunities for the realization and expansion of public and national benefits from the use of space.

The Balanced National Space Programme is not intended to supplant the existing Space Industry Development Strategy, but rather to augment the Strategy, addressing the totality of the emerging national requirements for space-based goods and services. In addition, it implies a more deliberate focus on matching the requirements of each sector of space activity with the resources needed to meet those requirements, and a closer harmonization between them.

Work is under way to formulate a framework for a broad-based national space programme. The objectives of this programme are:

- To define national requirements in both the public and private sectors, for space-based goods and services;

- To develop a national space sector capable of meeting the[ir] requirements; and

- To achieve a space-based export industry centred on Australia's comparative advantages: e.g., in science and technology, geography and investment opportunities.

This has introduced an important new element to the design of strategies for the delivery of Australia's national space requirements. Specifically, it has focused attention on the provision of public support for satellite remote sensing. This technology has grown since the early 1970s to become a key ingredient of Australia's space capability but has largely remained, with the exception of the major resource companies, confined to academic and research institutions and government. Now remote sensing has been targeted as that

component of the domestic space sector best positioned to address national requirements and assist in the resolution of national problems such as environmental monitoring and management, other terrestrial and oceanic applications and defence requirements.

In July 1990, the Space Board requested its Remote Sensing Committee to develop a plan of action for the development of Australia's remote sensing services capability. The Committee's terms of reference require that it identify Australia's remote sensing data requirements, determine who should meet these requirements and advise on strategies and actions for their realization.

The Remote Sensing Committee's report, released in February 1992, examines the role of remote sensing technology in a balanced national space programme. The report, published by the Australian Space Office under the title "Observing Australia", gives particular emphasis to the identification of Australia's remote sensing data requirements over the next two decades, utilizing the results of a survey of the remote sensing community conducted by the Office, and canvasses the measures required of government and industry to meet these requirements.

In September 1991, an expert Panel was formed to assess the performance of the National Space Programme and the appropriateness of the current space policy and programme for meeting Australia's future needs for space industry development, and for access to space goods and services. The review was required by a government decision taken in 1988, and its aim was to survey progress to date, the international context and prospects for the future. The Panel's report, which was released in July 1992, emphasizes the priority which needs to be given to Earth observation and the environment, to mobile communications, including navigation and position fixing systems, to aspects of launch services, to space science and to the Space Industry Development Centres' programme. It proposes, inter alia, that the National Space Programme be strengthened by replacing the Australian Space Board with a statutory Australian Space Council, membership of which would include senior representatives of government agencies and people drawn from the industry and space science communities. At the time of writing, the Government is considering the recommendations from the report.

PROJECTS AND PROGRAMMES

Land mobile satellite service antenna

From mid-1993 onwards, a new satellite mobile communications service will be introduced by OPTUS (formerly AUSSAT). New low-cost terminal equipment, in conjunction with more capable satellites, will enable communication of either speech or data with a vehicle, moving or stationary, through either a private communication network or the public switched telephone network. This service will be provided initially by OPTUS for the Australian market, followed by the International Maritime Satellite Organization (INMARSAT) with a global

service, and a North American service provided by the American Mobile Satellite Corporation in conjunction with Telesat Mobile Incorporated Canada.

Terminal equipment mounted in a vehicle will need to include a sophisticated antenna which, by beam shaping, optimizes the radio path to the satellite and, by beam steering, maintains the path as the vehicle moves. Present market estimates are for over 1.2 million terminal units to be in world-wide service by the year 2000.

The Office is providing assistance towards the development and commercialization of an electronically tracking, low-profile, vehicle-mounted prototype antenna for a mobile satellite communication service. The antenna which has been developed by the Commonwealth Scientific Industrial Research Organization (CSIRO), will be manufactured and sold through its commercial associate. The antenna has its principal market overseas. However, it is intended that first market entry will be in the domestic (OPTUS) market, in order to gain local experience and "settle down" the product before international exposure.

The Office is also investigating the scope for Australian industry involvement in the mobile terminal market.

Remote sensing

The Balanced National Space Programme has introduced a broader dimension to the development of strategies for the expansion of Australia's space capabilities, based on the potential of space activities to deliver national and public interest benefits. Subsequent analysis of our existing capabilities and future needs has suggested that satellite remote sensing will make an important contribution to meeting national requirements and assisting in the resolution of national problems. In the past two years, therefore, there has seen an increased focus on programmes, projects and activities directed at the upgrading of Australian remote sensing capabilities. In particular, the Office has supported activities which encourage the translation of remote sensing science and technology to socially and economically beneficial applications for Australian and regional markets.

It was recognized early that provision of remote sensing image processing systems and training would broaden the exposure of Australia's technical capabilities to remote sensing practitioners from 42 countries in the Asia and the Pacific region. This was also seen to provide an opportunity to highlight Australia's remote sensing capabilities and expertise in the region.

Exchange of observers between the Committee on Remote Sensing and the Australian Liaison Committee on Remote Sensing by Satellite (ALCORSS), to facilitate the provision of information between remote sensing organizations at the national level, continued in 1990-1991. The Office, in consultation with the Australian Centre for Remote Sensing (ACRES), also re-establishd the Commonwealth Remote Sensing Committee (formerly the Commonwealth Users Committee on Remote Sensing), to encourage discussion and consultation on

remote sensing issues affecting Commonwealth departments and agencies. The Committee will also serve as a forum for the formulation of Commonwealth views for presentation to ALCORSS and similar bodies.

The Office was a sponsor of the fifth Australasian Remote Sensing Conference in Perth in October 1990. Participants included representatives from the South-East Asian region, giving Australian industry the opportunity to demonstrate its remote sensing capabilities in a significant market region. In April 1992, as part of Australia's contribution to the International Space Year, the Office sponsored the Radar Remote Sensing Conference in Adelaide. This Conference introduced a new era of Earth observation and management through the application of radar remotely sensed data to a range of commercial and public-sector operations, including environmental management, civil engineering, mineral prospecting, fishing and oceanography.

Consistent with the approach to develop the remote sensing industry through coordination and liaison with other remote sensing centres/organizations, the Office provided funding for the position of a marketing-liaison officer for two consecutive years at the Western Australian Remote Sensing Industry Development and Education Centre. The Centre aims to consolidate the expertise and resources from CSIRO, the Western Australian Department of Land Administration, industry and universities. The purpose is to promote the application of remote sensing to resource management, thus serving government and industry.

Australia is making a significant contribution to the 1992 International Space Year through the Land Cover Change project. The Office is providing funding to the CSIRO Office of Space Science and Applications (CSIRO OSSA) to carry out this project. CSIRO OSSA will produce a set of reports in book, compact disk and video form, which will demonstrate the use of remotely sensed data for monitoring land cover change in selected areas of Australia, and widely disseminate the methodology and results of this work.

The Office also made the provision of a two-week training course and two remote sensing image processing systems to the United Nations Economic and Social Commission for Asia and the Pacific Region (ESCAP). ESCAP, a United Nations regional commission, conducts a remote sensing programme in the Asia and the Pacific region. A major objective of this regional programme is to contribute to the development of an indigenous remote sensing capability in countries within the ESCAP region for monitoring, developing and managing their environment and natural resources.

Involvement in remote sensing satellites

In the past, Australia's ability to receive and process satellite data as it became available has been hampered by a lack of appropriate ground sector infrastructure. A coordinated national approach is being developed to ensure that our reception facilities are properly configured and equipped to receive and use the data we require from the new generation of radar remote sensing

satellites. The Remote Sensing Committee's report incorporated a number of recommendations to facilitate this national approach, including the construction of a national X-band data reception network to ensure ongoing access to satellite data from the new generation of Earth observation satellites. In mid-1992, the Committee conducted a technical workshop to develop a tactical plan for Australian participation in the space sector of remote sensing systems, taking account of Australia's capacity to contribute to both regional and global remotely sensed data requirements. An important outcome of this exercise was the establishment of the National Data Needs Subcommittee of the Remote Sensing Committee, to consider Australia's regional and national data needs and the space-sector instruments and systems best equipped to meet these needs.

ERS-1 Phase C

This project involves upgrading the facilities of the Australian Centre for Remote Sensing to receive X-band signals and process high-speed data from the European Remote Sensing Satellite ERS-1. The project comprises the design, development and manufacture of the Data Acquisition Facility (DAF) at the ACRES receiving station in Alice Springs and the Data Processing Facility (DPF) at the ACRES head office in Canberra. The DAF tracks ERS-1 on 8040 and/or 8140 MHz and receives both high-rate (to 105 Mbps) and low rate (to 1 Mbps) data.

The system demodulates and records raw data on a high-density digital recorder for the production of synthetic aperture radar (SAR) image and wave products, radar altimeter, scanning radiometer and wind scatterometer products. The DAF was completed in 1990. The DPF is being designed to process SAR data and includes the development of the Australian Fast Delivery Processor (FDP) capable of processing the data at one tenth real time.

The FDP, which is being manufactured by British Aerospace Australia Ltd., is expected to be completed in September 1992. There are indications of the processor being internationally competitive, demonstrating Australia's technological capabilities and possibly leading to exports. The FDP is expected to be installed in the ACRES Canberra facility before the end of September 1992.

Multi-spectral imaging spectrometer

In a joint development venture with CSIRO and BHP Exploration Pty. Ltd., the Office awarded a contract for a feasibility study on imaging spectrometer technology. The work being undertaken includes imaging spectrometer system definition, optical design, detector selection and characterization, conceptual mechanical design, electronic systems design and the preparation of functional specifications. The technology addressed focused on space applications which utilize the visible, near infrared and short-wave infrared regions of the spectrum. The imaging spectrometer will be based on advanced charge-coupled device (CCD) technology with emphasis on the infrared. This study is expected to be completed in October 1992.

Along Track Scanning Radiometer (ATSR-2)

The first remote sensing satellite of the European Space Agency (ESA), ERS-1, launched in July 1991, is designed primarily to study the ocean surface and its interactions with the atmosphere. It will provide global measurements of wave height, surface wind and surface temperature, thus providing vital data to feed computer models that simulate climatic processes in atmospheric research and weather forecasting. ERS-2 was conceived as an identical follow-on to ERS-1, so as to provide continuity of the data or to provide a replacement for ERS-1 in the event of failure. The ERS-2 will be identical to ERS-1, with the following two exceptions:

- A separate Global Ozone Monitoring Experiment (GOME) instrument has been added; and

- The ATSR is enhanced by the inclusion of visible wavelength channels for monitoring of vegetation.

Under a collaborative agreement with the United Kingdom Science and Engineering Research Council, the Office is contributing to ERS-2. In return, Australia will be able to participate in the ATSR-2 science programme, and receive the scientific data from the instrument. Australian industry is undertaking the following work:

- Fabrication, integration and test of the Infrared Focal Plane Assembly (IR FPA); and

- Design, development, integration and production of the Electrical Ground Support Equipment (EGSE).

Auspace Ltd. has been contracted for the fabrication, integration and test of the IR FPA. Three separate models (vibration test model, flight model and flight spare) are to be delivered to the United Kingdom Rutherford Appleton Laboratory in accordance with a phased schedule for integration with the production of other ATSR-2 components, particularly the visible focal plane assembly. The initial design of the ATSR-1 IR FPA was undertaken by Rutherford Appleton Laboratory; however, Australia was requested to participate in the redesign necessitated by the incorporation of three visible wavelength channels. The IR FPA flight model was completed in May 1992.

The EGSE is used to support the functional testing, calibration, performance demonstration and acceptance testing of the ATSR-2 instrument. It will also support the integration, checkout and functional operation of the ATSR-2 throughout the verification programme from instrument level through to satellite level. The EGSE was contracted to British Aerospace Australia and was completed in February 1992.

Atmospheric Pressure Sensor

The Atmospheric Pressure Sensor (APS) is a passive remote sensing instrument to be developed by CSIRO to measure atmospheric pressure at the Earth's surface from a satellite platform. The instrument will use a high-resolution spectrograph tuned to the oxygen A-band (759-770 nm) which, by analysing the absorption by oxygen of reflected sunlight, will determine the mass of oxygen in a column of atmosphere. The surface pressure can then be deduced. Although technically simple, a passive system requires a higher spectral resolution to enable the distinction between the scattered and reflected components of the radiance reaching the sensor. In addition, the surface pressure deduced from passive systems is sensitive to irregular variations in atmospheric aerosol concentrations, temperature profile and instrument signal to noise performance.

The Office recognizes the importance of Australian involvement in satellite sensor design and of the Australian contribution to the global meteorological satellite network. Accordingly, the Office is supporting the project to determine the scientific and engineering feasibility of the APS. This study, referred to as the APS phase A study, is required to:

- Establish the scientific feasibility of the project in accordance with a programme defined by the CSIRO Division of Atmospheric Research;

- Establish the engineering feasibility of the project;

- Specify the functional and environmental requirements of the APS and the standard to which it must be built; and

- Establish a timely and orderly development and production schedule for a space-qualified instrument.

The APS phase A study is scheduled for completion in March 1994.

Tasmanian Earth Resources Satellite Station (TERSS)

During the 1990s, a new generation of satellites designed for environmental monitoring will be launched. These satellites will be equipped with advanced instruments such as high-resolution radar which promise to improve dramatically our understanding of environmental processes both on land and in the oceans.

Some instruments on these satellites will transmit information at such high rates that the data cannot be recorded on board; rather, if data are required for a particular region, it will be necessary to receive the data in real time from a tracking station in sight of the satellite. At present, only one Australian receiving station, operated by ACRES at Alice Springs, will be able to receive data directly from these satellites.

In order to take advantage of the benefits these new satellites offer and to maximize Australian area coverage, it will be necessary to establish a number of strategically located X-band satellite reception stations around Australia. TERSS is a proposal to build a prototype satellite receiving station in Hobart capable of receiving down-linked remotely sensed data in the X and S frequency bands from both current and planned Earth resources satellites. The station is being developed by a consortium headed by the University of Tasmania and the CSIRO Division of Oceanography. The station is expected to cost $2.5 million and to be operating by May 1993.

In December 1990, the Office also provided financial assistance to the project, as it considered the project to be an important contribution to the national space infrastructure, with benefits to industry and researchers. For example, TERSS would improve scientific knowledge of the Southern Ocean, which has significant influence on the world's climate and is likely to play a major role in the greenhouse effect.

Endeavour project

The Endeavour project has involved the design and manufacture of an ultraviolet binocular telescope optimized for the wavelength region of 150-160 nm. The payload is an experiment to space-qualify the UV light detector. This detector is an intensified CCD unit using digital centroiding logic to obtain high resolution, high count rate and large image area. The intensification is obtained by use of a microchannel plate image tube which is used as a low-noise, high-gain photon amplifier. The intensified light is transferred to an array of CCD image sensors via a fibre-optic image dissector. The CCDs convert the amplified photon events into video speed analogue electrical signals. These video signals are amplified, buffered and recorded. After the flight, the recorded video signals are played back and sent to the ground image processing equipment where the photon events are counted and centroided to form the image. Endeavour was flown on the NASA Space Shuttle under the Get-away Special flight opportunity programme in January 1992.

Radioastron

Radioastron is a Russian radio-astronomy satellite, and Australian industry is involved in the development and manufacture of a low-noise L-band receiver under a collaborative arrangement. The satellite will be injected into a very high-apogee orbit and will carry a radio-telescope which, in conjunction with ground-based radio-telescopes, will make observations of radio sources in space through the use of very long-baseline interferometry. The L-band receiver system comprises dual-channel low-noise amplifiers (LNAs) and down converters for right- and left-hand circularly polarized signals at 1600 MHz. The system is housed in two separate areas designated Box 1 and Box 2. Box 1 contains the LNAs and some pre-filtering and calibration couplers and is mounted in free space on a cryo-plate close to the antenna focal point. The cryo-plate is maintained at a temperature of 80-100°K by the spacecraft cooling system. Box 2 contains the remainder of the receiver

system and is mounted in the focal package which maintains the system at nominal ambient temperature and pressure conditions. The L-band receiver system is about to undergo life-cycle testing, with project completion planned for September 1992.

Cape York Spaceport

The proposal to build a launch facility on Cape York is a commercial initiative. Initial development of the concept was undertaken by a consortium led by Cape York Space Agency Pty. Ltd. The concept involved a plan in which the company would purchase Zenit rockets from the former USSR for use in an Australian commercial launch service which would operate in competition with existing launch services around the world. The proposed spaceport has the potential to offer significant economic benefits to Australia. Industry will also benefit, from construction and operation work at the spaceport itself, from industrial activity directly associated with the spaceport such as the manufacture of rocket fuel and components and from spin-off industries and the consequent boost provided to space industry development.

In order to assist companies in assessing the investment opportunity, the Office contracted the Australian Industry Development Corporation (AIDC) Ltd. in February 1991 to provide an independent report on the financial and commercial aspects of the spaceport construction and operation. AIDC furnished its report to the Space Office in early November 1991. The report confirmed the project's commercial viability and indicated that the projected rate of return was sufficiently high to attract the international aerospace community.

Discussions have commenced with a new international consortium which had registered interest in the spaceport. This new group, Cape York International Spacelaunch Limited, is a combined English-Australian venture which lists participants from the Netherlands and the United States of America.

Other launch services

Launch services activities during 1990-1992 focused on facilitation of the Cape York spaceport proposal, discussed above, and the development of an Australian Launch Vehicle.

The Australian Launch Vehicle was originally proposed in 1988 by Australian Launch Vehicles Pty. Ltd. and Transfield Pty. Ltd. The concept was for a low-cost, Australian-produced launch vehicle, which would be operated on a commercial basis from the Woomera range to place payloads in the 500-1000 kg range into low Earth orbit. A major element of the proposal was that the Federal Government be the customer for the first two flights and associated payloads, as a means of establishing commercial credibility for the project.

In the latter part of 1990, an Australian consortium comprising ALV-Transfield, Auspace, AUSSAT, British Aerospace Australia, Hawker de Havilland and Vipac prepared a tender proposal, nominating the

launch vehicle for deployment and maintenance of the Motorola Iridium satellite fleet. Motorola deferred making a decision, but expressed interest in the Australian Launch Vehicle.

In October 1991, a contract was placed by the Space Office with British Aerospace Australia as lead contractor for the teaming partners (Hawker de Havilland and Auspace). The contract covers the conduct of a project definition study which includes significant assessment and specification of the launch vehicle design parameters. The plan involves two prototype launch vehicles, the first of which is scheduled to be launched from Woomera in late 1994. Following completion of the study, the teaming partners anticipate that the concept will be sufficiently proven for them to be able to obtain substantial funding support from commercial sources.

Space Industry Development Centres

In June 1991, the Space Board agreed to the establishment of three new Space Industry Development Centres (SIDCs) to complement the existing Australian Space Centre for Signal Processing located at the University of South Australia. Introduced under the Infrastructure Development Programme of the Australian Space Industry Development Strategy, the SIDC Programme is a collaborative research-and-development activity aimed at promoting space related research and development in order to develop Australian products and services capable of competing in international markets.

The new centres are:

- A space industry development centre for space engineering, a joint venture between the universities of Adelaide, South Australia and New South Wales, being set up at the University of Adelaide as an Australian and Pacific regional focus in space industry related space engineering research and applications and providing a key strategic engineering capability for companies developing products or systems for spacecraft;

- A space industry development centre in microwave technology, a cooperative establishment between Griffith University, the University of Queensland and Mitec Ltd., to be located within Griffith University, to design and develop a wide range of microwave hardware for satellite systems and to assist Australian firms in becoming internationally competitive at major contract and subcontract levels for the design and manufacture of microwave flight hardware;

- A space centre for satellite navigation technologies, a joint venture between the Queensland University of Technology, the University of New South Wales and Auspace Limited, to be located within the Queensland University of Technology to establish an Australian research-and-development capability in satellite navigation systems aimed at becoming an internationally recognized

research centre for developing advanced systems for satellite navigation and positioning.

All centres are intended to have an ongoing existence, beyond the life of the initial projects being undertaken and beyond the period for the provision of Office funding. Office funding is being provided for a maximum of five years after the establishment of each centre under the programme and is of two types:

- An annual allocation of $A 25,000 to each centre to defray administration expenses and costs of marketing and promoting the centre; and

- Up to $500,000 each financial year, on a dollar-for-dollar basis to each centre, for specific research and product development projects approved. Office funding for any one research-and-development project will not exceed 50 per cent of that project's lifetime costs.

The research and development programme, inspired by the Centres for the Commercial Development of Space, administered by the National Aeronautics and Space Administration (NASA), contains two elements of fundamental importance to the concept of the SIDC:

- A high level of private-sector commitment to the establishment of the Centres, including support through direct funding and application of company resources; and

- A focus on research and product development targeted at identified market opportunities.

Operational functions

Under an inter-government agreement between Australia and the United States, the Space Office is responsible for the management of the Canberra Deep Space Communication Complex (CDSCC) at Tidbinbilla, near Canberra, and the MOBLAS-5 satellite tracking laser at Yatharagga, Western Australia, on behalf of the United States.

CDSCC maintained a busy schedule of tracking operations during the period under review. Regular communications were maintained with a suite of eight NASA deep spacecraft and a number of Earth-orbiting satellites. Notable features of operation included the first cycle of the mapping of the surface of Venus by the Magellan spacecraft and the execution of the initial gravity assist trajectory of the Jupiter-bound Galileo spacecraft around Venus.

Additionally, the launch of the Ulysses spacecraft on a mission to observe the polar regions of the Sun was supported, and continued tracking of the two Voyager spacecraft on the first part of their interstellar mission took place.

Space astronomy

The Anglo-Australian Observatory (AAO) is fully committed to operating its ground-based telescopes at Siding Spring Observatory, and does not normally have any direct involvement in space activities. However, the Anglo-Australian Telescope (AAT) is one of the premier facilities for optical and near-infrared observing, and the results of space astronomy experiments frequently require it to be used for follow-up observations. There is thus a synergy between space- and ground-based astronomies that is epitomized by the AAT.

In addition, individual research staff members at AAO have some small involvement with current space astronomy missions. Elaine Sadler, in collaboration with Susan Simkin (of Michigan State University, United States) has been using the Hubble Space Telescope to image the central regions of radio galaxies, with the aim of understanding the mechanism by which gas is fed into the active nucleus. And Jeremy Bailey is involved in working on the accreting, magnetic white dwarf systems known as AM Herculis binaries. For this work simultaneous observations are made with the AAT and with the ROSAT satellite. High time resolution observations of the eclipsing system UZ For were obtained with ROSAT in July 1991, and will be analysed in conjunction with optical light curves to study the geometry of the emitting regions. The optical light curves obtained for this object clearly show, for the first time, the eclipse of two cyclotron emission regions from near the two magnetic poles of the white dwarf. Similar work is being planned for another star.

Asteroids and comets

Having begun in May 1990, the Anglo-Australian Near-Earth Asteroid Survey is the first search programme for mankind-threatening cosmic impactors to be carried out from the southern hemisphere, complementing the three such programmes operating in the United States; occasional discoveries are also made elsewhere. This programme operates at the Anglo-Australian Observatory, with funding from the Australian Research Council. Due largely to the efforts of R. H. McNaught, to date about 10 per cent of the inventory of Earth-crossing asteroids discovered since the first in 1932 has been detected as a result of this initiative. Two members of this team (D. I. Steel and K. S. Russell) have served on a NASA committee charged by the United States Congress with recommending a programme to greatly enhance the world-wide discovery rate, and Steel also served on another NASA committee to recommend how any identified near-term impactor might be dealt with (interception and deflection/destruction). Steel is also a member of the International Astronomical Union's Working Group on Near-Earth Objects, and is on the Board of Trustees of the International Institute for the Problem of the Asteroid Hazard in St. Petersburg, Russia.

At the request of the European Space Operations Centre (ESOC), astrometric positions of the Grigg-Skjellerup Comet were determined using a variety of instruments from April 1992 through to a few days before the

encounter with that comet by ESA's Giotto probe on 10 July, thereby assisting the targeting of the spacecraft to within about 200 km of the cometary nucleus.

AUSTRALIAN SURVEYING AND LAND INFORMATION GROUP

The Australian Surveying and Land Information Group (AUSLIG) is an Australian Government agency providing commercial and public-interest land and geographic information services to government agencies, business and the general public. AUSLIG's space-related activities include remote sensing and geodesy through its Australian Centre for Remote Sensing (ACRES) and Geodesy Unit, respectively.

Australian Centre for Remote Sensing

The Australian Centre for Remote Sensing comprises an Operations element, outsourced from Computer Sciences of Australia, which is responsible for satellite data acquisition, processing and sales as a community service obligation activity, and an Applications group, undertaking projects and generating value-added products on a quasi-commercial basis.

Operational status

ACRES continued to receive TM and MSS data from Landsat-5, which is operating nominally. An upgrade, to be carried out in early 1993, will allow data from Landsat-6, due for launch in January 1993, to be received and processed. Landsat-6 will carry an Enhanced Thematic Mapper (ETM) instrument which will retain all of the seven separate spectral bands and 30 m spatial resolution of the current TM instrument but include a co-registered panchromatic band with 15 m spatial resolution.

Regular reception and processing of data from SPOT 1 began in May 1990 and, at present, data from both SPOT 1 and 2 are being received and processed. Daily passes of Advanced Very High Resolution Radiometer (AVHRR) data from the NOAA 11 and 12 satellites are also received at Alice Springs, providing nation-wide coverage.

Experimental quantities of data from the Japanese MOS 1 and MOS 1b satellites were received by arrangement with NASDA, through the CSIRO Office of Space Science and Applications, which is distributing products to its investigators.

Reception and archiving of ERS-1 SAR data began in August 1991 following the launch, by the ESA, of the ERS-1 satellite in July 1991. British Aerospace Australia installed ERS-1 reception equipment at ACRES Alice Springs and is contracted to the Australian Space Office to deliver the SAR Fast Delivery Processor to ACRES Canberra by October 1992. A limited number of scenes have been processed on the FDP to ascertain processing speed and data quality.

A recent upgrade allowed the reception of data from the Japanese satellite JERS-1. Data from both the optical (OPS - a multispectral imaging radiometer with a spatial resolution of 18m x 24m with an along-track stereoscopic capability) and synthetic aperture radar (SAR) sensors was satisfactorily recorded. A sample of these test data will be sent to Japan for processing and validation. The ACRES processing of JERS-1 data will not occur until early 1993.

Distribution and archiving media

An optical tape recorder, capable of storing 1 terrabyte of data on a single optical tape, was purchased to overcome the foreseeable archiving problems at ACRES and to ensure longevity of the early High Density Data Tape (HDDT) archive. Two more recorders are planned to be integrated into the processing system.

Historically, ACRES digital data have only been available on nine-track magnetic tape. With the advent of new media, ACRES offers data on floppy disk and plans to offer data on 8 mm cartridge (Exabyte) and digital audio tape.

International activities

ACRES representatives attended the following meetings of the international remote sensing community:

- Ground Station Operators, SPOT;
- Landsat Ground Stations Operators Working Group (LGSOWG 20, 21 and 22);
- Landsat Technical Working Group (LTWG 14 and 15);
- Directors of the National Remote Sensing Centres/Programmes in the ESCAP Region and the Intergovernmental Consultative Committee on the Regional Remote Sensing Programme (meetings 6, 7 and 8);
- Ground Station Operators, ERS;
- CEOs Working Group on Data (meeting 12).

Applications

The Applications group undertakes projects on a quasi-commercial basis for mainly Commonwealth government departments. Major projects are currently being undertaken for CSIRO, Primary Industries and Energy, Arts, Sport, the Environment, Tourism and Territories and the Civil Aviation Authority. Support is also provided to AUSLIG's series mapping and database programmes.

Along with other AUSLIG units and private industry, the Applications group has continued to develop the direct printing of digital data on film for

the cost-effective printing of multiple copies. This technology is attracting great interest from agencies with a need for maps, posters and brochures with an image base.

Image analysis and processing are currently being undertaken using DISIMP ported on an Apollo and HP workstation with 6250bpi tape drive for I/O. The original microBRIAN PC was recently upgraded to 486 standard including a 600Mb hard disk. The ACRES MERIDIAN system is utilized for highly specialized processing and interfacing with the ACRES Colour FIRE image-writer.

GEODESY

Laser ranging

The laser ranging observatory at Orroral was operated by the Australian Surveying and Land Information Group (AUSLIG) continuously during 1990-1992. A series of technical and processing improvements produced improvements in precision and productivity in 1987 and 1989. Terrestrial target ranging was introduced late in 1989, demonstrating an internal system accuracy in the vicinity of 5 mm.

Ranging to Lageos was the main ranging activity in the past two years and ranging to the Etalon 1 and Etalon 2 satellites was started in May 1990 with a 2.5 cm accuracy. Ranging to Ajisai and Starlette was commenced in April 1991. These activities support the NASA Crustal Dynamics project and the International Earth Rotation Service.

Lunar ranging was attempted on an ad hoc basis throughout the period, but without success.

A substantial system upgrade, in collaboration with a local high-technology company, Electro Optic Systems Pty. Ltd., was commenced in December 1990. Its aim is to achieve 5 mm precision and accuracy reliably for routine ranging to all targets from terrestrial to geostationary distances, to encompass low satellites such as ERS-1 and Topex/Poseidon and to allow resumption of regular lunar ranging.

The laser modifications have been installed and tested, and the upgraded capacity to range to low satellites has been demonstrated. Two-colour ranging will be investigated in the future.

AUSTRIA

[Original: English]

Space activities in Austria that could be the subject of greater international cooperation, with particular emphasis on the needs of the developing countries, cover the topics of telecommunication and Earth observation. These tasks are performed in close cooperation with the European Space Agency (ESA) by contributions of the Federal Government to the relevant budgets and by carrying out industrial and scientific work for the following programmes:

(a) Telecommunications:

(i) Olympus telecommunications satellites;

(ii) Advanced systems and technology programmes;

(iii) Payload and spacecraft development and experimentation programmes;

(iv) Data relay technology missions;

(b) Earth observation programmes:

(i) European remote sensing satellite ERS-1;

(ii) European remote sensing satellite ERS-2;

(iii) Earth Observation Preparatory Programme (EOPP-Extension);

(iv) Polar Orbit Earth Observation Mission (POEM-1);

(v) Development of an optical link for precise range and range rate detection (part of PRAREE instrument).

Data from European remote sensing satellites and from Earth observing missions of the other nations can be provided to interested users and scientists for further analysis. In the framework of the ERS-1, a satellite link for fast-delivery Synthetic Aperture Radar (SAR) data has been set up by installation of a receiving terminal in Austria. Several scientific groups are analysing these data for different fields of application.

Spin-off benefits of space activities have been reported from different firms engaged in space development activities, which are performed mainly under European Space Agency (ESA) contracts. As a result of the work on projects such as autonomous robotic control simulation, equipment manipulation and transportation system and gripper/tool technology for automation and robotics special force-controlled gripper systems for industrial applications and research use have been developed. Within the Hermes programme an Austrian company built up its expertise in the handling of human and other solid

waste. The potential market for this development can be found in medical intensive-care stations and in high-speed transport systems for waste disposal without any microbial contamination in a closed and/or controlled environment.

Electro-optical modulators for laser communication linking two satellites as well as precise opto-mechanical systems working in two axes for exact pointing of laser beams with a resolution of +/-1 microrad have been developed. The latter can be used in different terrestrial applications requiring such high accuracies.

Small advanced SATCOM terminals, using spread-spectrum CDMA technology, have been developed and can now be installed as satellite communications Earth stations in developing countries.

A recently developed satellite video conferencing system for video, audio and computer graphics transmission between two or more terminals by using satellite links has been tested in different practical applications and is now ready for implementation. This system provides the same communication means and social presence as in "conventional" meetings.

BELGIUM

[Original: French]

I. OBJECTIVES

Belgium's participation in European space activities affords the Belgian scientific community an opportunity to collaborate in international - and often global - scientific projects and experiments and Belgian industries (which stand to benefit the most from the spin-off) an opportunity to become full partners in complex, high technology projects, undertaken within the framework of international industrial cooperation.

The history of European space policy is that of a long effort to ensure Europe's autonomy in the area of launchers and satellites. From the outset (that is to say since the early 1960s) Belgium's goal has been to make its industry the sole source for the design and production of certain systems and sub-systems for the European Space Agency (ESA) and European industrial consortiums associated with the Agency, and to offer Belgian scientists the possibility of sharing in the advances in knowledge resulting from experiments carried out in orbit.

The attainment of this objective has required a continuity of strategy over nearly thirty years which has been reflected in Belgium's participation in most of the Agency's scientific and applications programmes. It has also required the selection of technological market segments within the framework of a specialization policy agreed upon between the State and the industries concerned in the light of the opportunities offered by the Agency's programmes.

Belgium's space industry specializes, inter alia, in:

- On-board power package systems for satellites;
- Control and test units;
- Ground stations;
- Structures and servo-mechanisms.

The Belgian scientific community participates in space research activities in many areas, including:

- Astronomy and astrophysics;
- Study of the solar system;
- Geodesy;
- Meteorology;
- Remote sensing;
- Life and materials sciences in microgravity;
- Microwaves, etc.

II. BACKGROUND

Belgium ratified the Convention on the European Space Agency (ESA) on 3 October 1978.

An intergovernmental agreement between Belgium and France, signed on 20 June 1979 and followed up by two supplementary agreements signed on 13 November 1984 and 23 October 1991, respectively, provides for the participation of Belgian industry in the development of the satellite remote sensing system (SPOT). The royal decree of 15 December 1982 instructed the National Investment Corporation (SNI), on behalf of the Belgian State, to purchase shares in the company SPOT-IMAGE, which had been established to market SPOT data.

On 10 February 1988, Belgium acquired shares in the three main optional programmes of the European Space Agency, as set out below:

- European launcher Ariane-5: 6.0 per cent;
- European shuttle Hermes: 5.8 per cent;
- Columbus space station: 5.0 per cent;

This decision followed the commitments undertaken at the ministerial conferences of the member countries of the European Space Agency, which were held at Rome in January 1985 and at The Hague in November 1987.

The Minister of Scientific Policy signed the intergovernmental agreement on cooperation between European States participating in Columbus, the United States of America, Japan and Canada, on 29 September 1988. On 21 December 1990, the Council of Ministers decided that Belgium would participate in the MIRAS programme, which provides for an atmospheric observation spectrometer of Belgian origin to be carried aboard the Russian orbiting space station Mir-2, in 1994. On 21 November 1991 the Council of Ministers announced its support for the updated long-term plan of ESA, which was submitted to the ministerial conference held at Munich in November 1991.

III. PROGRESS OF ACTIVITIES

Within the Science Policy Programming Services (SPPS) space activities are administered by a "Space" unit whose responsibilities include providing for Belgium's representation in the organs of ESA, monitoring industrial activity in Belgium and negotiations with official international and foreign agencies. Activities are currently under way in several sectors.

A. ESA

Since becoming affiliated with the three optional space infrastructure programmes - Columbus, Ariane-5 and Hermes - which have entered their development phase, Belgium has been participating in the Agency's user programmes. These are the Earth observation, telecommunications and microgravity programmes, which significantly strengthen the economic and scientific benefits derived from space activities.

Earth observation programmes are of benefit mainly in the development of scientific instruments which will be carried aboard the Columbus polar platforms. The telecommunications programmes will facilitate the development of data-relay satellites and related technology. They will also promote the development of future generations of telecommunications satellites as well as ground-station technology, so that optimum use may be made of space infrastructure and of satellite telecommunications in general. The microgravity programme will promote the development of instruments used by all European experimenters. Instruments specific to selected Belgian experimenters are financed nationally.

The Agency's (mandatory) scientific programme will be progressively strengthened.

Belgium was also successful in obtaining the installation on its territory of the training centre for pilots of the European shuttle Hermes.

B. SPOT

Belgian industry is associated with the development of the remote-sensing satellites in the SPOT series: SPOT-1, launched on 11 January 1986; SPOT-2, identical to SPOT-1 and launched on 21 January 1990; SPOT-3; SPOT-4, and with the system's ground segment.

C. MIRAS

Belgium participates in the MIRAS programme, whose objective is, as proposed by the Belgian Institute of Space Aeronomy, to place an Earth observation infra-red spectrometer on board the Russian orbiting space station Mir-2. Mir-2, which is scheduled for launching in 1994, will offer the possibility of continuous global observation for several years. The instrument will permit synoptic, homogeneous and repetitive measurements to be made, particularly of trace molecules in the Earth's atmosphere.

This scientific cooperation between Belgium and Russia is covered by an agreement signed on 9 September 1990 between the Russian and Belgian authorities.

D. Projects under preparation

1. SPOT project

The intergovernmental agreement between Belgium and France has provided for Belgian participation in the development of the satellite remote-sensing system (SPOT). An extension of this project, 50 per cent of which is funded by the European Community, is aimed at monitoring natural and man-made continental ecosystems using an instrument known as, "Végétation" to be carried aboard the SPOT-4 satellite. The scientific and industrial communities have a direct stake in the development and utilization of this payload. Quite apart from its scientific interest, it is clear that the development of such a payload represents a considerable contribution to environmental policy and received the attention of all the Governments represented at the ministerial conference at Rio de Janeiro.

2. SPICAM project

This project involves development by the Belgian Institute of Space Aeronomy of a payload for the study of the atmosphere of the planet Mars during the Russian "Mars 94 Mission". The purpose of the Belgian instrument is to gather data for the international and Belgian scientific communities.

In all these various activities, three concerns are constantly present:

- as regards industry, to secure a fair return on Belgium's contribution to European and foreign programmes in the form of contracts awarded to Belgian companies;

- at the scientific level, to facilitate access by Belgian researchers to the most advanced equipment and to the results of experiments conducted in space;

- in the context of future prospects for the use of space for industrial and commercial purposes, to ensure returns on the significant investment made by the country and to ensure that Belgian industry finds its place in the industrial structures which will be taking advantage of the new markets that are emerging.

CUBA

[Original: Spanish]

Cuba is carrying out a programme involving the use of remote sensing for the study of natural resources with applications for agriculture and water resources management. It has the minimum resources in personnel and equipment necessary for this programme. However, Cuba needs increased international cooperation in order to acquire satellite images and data and to obtain and modernize the necessary technical equipment. For its part, Cuba is able to offer technical services in cartography and thematic processing, as well as other services which make use of special techniques in this field.

CZECHOSLOVAKIA

[Original: English]

The significant success of the space research in the Czech and Slovak Federal Republic is represented by the launching of the small Czechoslovak satellite Magion-3, which was put into orbit in December 1991 together with its mother satellite Intercosmos-25 within the framework of the international Apex project. The research aim is the study of the cold plasma. Magion-3 has been functioning independently since 28 December 1991 and, inter alia, serves as an independent diagnostic system for the detection of the response of an active experiment being carried out on the mother satellite.

The operation of the Czechoslovak satellite is controlled by the telemetric station of the Geophysical Institute of the Czechoslovak Academy of Sciences, in Panská Ves, which at the same time serves for the reception and storage of data. Magion-3 is still operating without defects. During the period of its active operation, large files of data have been obtained which may be processed with the participation of interested parties within the framework of broader international cooperation.

Work continued on the analysis of the measurement of energetic space particles in the Earth's magnetosphere at low altitudes, obtained from the international projects Active (the satellites Intercosmos-24 and Magion-2, launched in 1989) and Apex, in the transition field and before the shock wave in the vicinity of the Earth on the basis of data gathered by the satellites Prognoz-8 and 10 (Institute of Experimental Physics of the Slovak Academy of Sciences, Košice).

A large set of data gathered during the six months' measurement by Prognoz-10 revealed the dependence of the flow of medium-energy particles (over 10 keV) on the position, geomagnetic activity and geometry of the shock wave. This knowledge enables the testing of the current theories on the origin of particles in the vicinity of the Earth's shock wave (Institute of Experimental Physics of the Slovak Academy of Science, Košice).

In June 1992, functional testing of the technological sample of the micro-accelerometer developed at the Institute of Astronomy of the Czechoslovak Academy of Sciences was carried out on board the Resurs-F satellite. This testing showed good operational performance of the device, and the data gathered through its activation during flight are in full concordance with the theoretical hypotheses. The micro-accelerometer is intended for gathering basic data on the surface forces acting upon satellites, and by its sensitivity it should outperform other such instruments currently in use.

Under conditions of short- and long-term micro-gravitation, the process of uneven solidification of melts was studied. Using model samples of Ag-Ge and $PbCl^2$-AgCl systems, further evidence was obtained on the increased tendency of multi-composite melts to under-cool under conditions of weightlessness, thus confirming the results of previous Czechoslovak experimenters. It was further revealed that in the absence of flow a concentration gradient limiting towards the minimal free energy of a given system is formed in multi-composite melts and thus the phase decreasing the surface tension of melts migrates towards its surface. As a result, the crystallization in the drops of the liquid does not take place at certain gradients of temperature from their colder surface, but vice versa. The experiments were carried out in cooperation between the Czechoslovak research laboratory of the BBT-Materials Processing Company (Prague), the laboratory of MUSC-DLR (Cologne, Germany), ZARM (Bremen, Germany) and the industrial consortium Energia (Moscow).

Within the study of fields of radiation in the vicinity of the Earth, detectors exposed to radiation in open space during the period from June to October 1991 were evaluated. The detectors were placed on the surface of the Mir station. Highly significant results were obtained through the analysis of the upper layers of the detectors exposed during the solar eruptions (Institute of Radiation Dosimetry of the Czechoslovak Academy of Sciences).

Further, a number of series of measurements were carried out on board the aircraft of Czechoslovak Airlines. The results obtained will enable a more precise determination of the degree of radiation load of the crew of civilian aircraft (Institute of Radiation Dosimetry of the Czechoslovak Academy of Sciences).

Work has continued on the preflight preparation of the Czechoslovak infrared spectrometer Istok-1 for the scientific module of the Mir station within the international project Priroda.

Testing was done on the use of Landsat satellite TM images for the classification of soil types in the Danubian lowlands area.

Research was carried out with the aim of using TM data for mapping the type of soil coverage in urban and rural built-up areas for satisfying the requirements for planning sewerage networks.

The possibility was analysed of using information from the SPOT satellite as an information input to geo-information systems on environment used by Czechoslovak district authorities.

Preparatory work was done for CORINE, the all-European information service on the environment, on Land Cover mapping of the entire country at a scale of 1:100,000 using TM photos from the Landsat satellite, and of selected portions of the country at a scale of 1:50,000 from the SPOT satellite.

Analyses were done of the hormonal levels (especially of catecholamines) of the biological material obtained during the joint flight of the Austrian and Russian astronauts. Levels determined in this way should become the basis for the evaluation of stress factors of short-term space flights (Institute of Experimental Endocrinology of the Slovak Academy of Science, Bratislava).

Cooperation with the Physiological Institute in Graz, Austria, is continuing and is aimed at the observation of the influence of negative pressure upon the lower part of the body of astronauts in microgravitation.

ECUADOR

[Original: Spanish]

With regard to paragraph (a), the Government of Ecuador received assistance from the countries in the area covered by the Cotopaxi antenna in installing and bringing into operation this station. This support has been described in various international meetings on space technology. Since this project benefits the region as a whole, it has been suggested that the United Nations should sponsor a study to identify the most suitable arrangements for ensuring the participation of all countries in the area of coverage. Towards this end, it would be appropriate for the Cotopaxi station to receive technical and financial assistance from the United Nations and the operators

of the different satellite systems. Assistance is particularly needed in the areas of operation and maintenance, payment for frequencies and transfer of technology.

With regard to paragraph (b), the benefits of the proposal for the countries involved in the project will be twofold: (i) availability of regularly updated data from the LANDSAT, SPOT and ERS-1 satellites and any others from which data may be received in future, in order to undertake studies and research into natural resources and the environment; and (ii) to obtain and develop technology suited to specific conditions in the individual countries in order to put data obtained from satellites to optimum use.

GERMANY

[Original: English]

The peaceful uses of outer space and the development of space technology are regarded by Germany as primarily an international task. Participation in multilateral and bilateral programmes and projects therefore is the centrepiece of German space activities. One important aspect in this respect is that the benefits of the use of outer space should be spread as widely as possible. To that end, Germany is actively participating in United Nations activities centring in its membership in the United Nations Committee on the Peaceful Uses of Outer Space.

In the following, the first section of this brief report on German activities gives an outline of the organizational structure of the German space management. The second section describes international commitments by participation in the European Space Agency (ESA), the United Nations and International Space Year, 1992. Finally, a short enumeration of German national activities with bilateral and multilateral scope is given in the third section.

I. ORGANIZATION

An assessment of the management structure for space activities was conducted in Germany during the second half of the 1980s after the political decisions for European autonomy regarding space flight issues were made at ESA's Ministerial Council in Rome in 1985 and the adoption of the Long-Term Plan by the ESA Ministerial Council at The Hague in 1987. The growing international and national commitments by Germany then resulted in the decision of the Cabinet of the Federal Government to create a new management structure, capable of handling these tasks, i.e., a Cabinet's Space Committee, a State Secretaries' Space Committee and the German Space Agency DARA (Deutsche Agentur für Raumfahrtangelegenheiten GmbH).

The Cabinet Committee on Space Activities is responsible for preparing the Federal Government's space policy decisions, as well as fundamental

strategies and planning aspects. It advises on the allocation of the federal budget. Funds are made available to DARA from the responsible ministries. The Cabinet Committee's activities are prepared by the State Secretaries' Committee on Space which is also responsible for coordinating the space interests and activities of the various ministries involved. It sets goals and guiding principles to DARA. DARA was established on 26 April 1989. DARA is chartered by special federal law, conveying governmental responsibilities upon it. It has the legal status of a company with limited liability. The Federal Government is the sole shareholder. DARA's Supervising Board consists of representatives of the German Federal Government and industry and science. The work of DARA is based on efficient business management, guaranteeing flexibility and mobility as well as the desired proximity to industry and science.

As the central management organization for the coordination of German space activities, DARA must draw up plans for German space policy for approval by the Federal Government, which includes: planning German participation in international programmes and projects; planning national projects with due consideration for European, bilateral and multilateral programmes; technological, economic and financial recommendations, analyses and project proposals.

Furthermore, DARA must implement and manage the German space programme and award contracts and grants to industry and science. In particular, this consists of advising and assisting the federal ministries and public institutions involved, as well as coordinating activities with industry and scientific institutions; promoting, directing and monitoring projects, and evaluating their results; planning and coordinating the operating facilities; initiating and promoting commercialization; allocating and contracting funds from the space budget in accordance with its statutory authority and determining financial requirements.

Finally, DARA must represent German space interests in the international arena, particularly vis-à-vis ESA by representing the German position within the committees of ESA and other international organizations (in so far as this is not done at the ministerial level for political reasons); participating in drawing up and controlling ESA prgrammes; and representing the German position in the implementation of multilateral and bilateral agreements.

A Technical and Scientific Advisory Board ensures that the respective requirements are taken into account. Several ad hoc advisory committees are established for specific topics.

Currently, DARA manages approximately 500 projects and studies, and awards contracts to about 130 scientific institutes and industrial companies.

In close cooperation with DARA, the German Aerospace Research Establishment, Deutsche Forschungsanstalt für Luft- und Raumfahrt e. V (DLR), has as its primary responsibility to execute research elements of the national programmes and some of the German contributions to the European large-scale

space projects. With more than 4,500 employees, including some 1,600 scientists, DLR is the largest research establishment for engineering sciences in the Federal Republic of Germany. Its research centres are located in Berlin, Braunschweig, Göttingen, Cologne, Oberpfaffenhofen and Stuttgart.

Besides astronautics, DLR focuses on aeronautics and energy technology. In coordination with industry and universities, basic research and development tasks are planned on a long-term basis. These tasks require continuous processing in a multidisciplinary network and cannot be undertaken by industry alone because of the financial risk involved, due to the high rate of investment necessary for the large-scale test facilities.

DLR's scientific-technical expertise lies with the institutes of its five scientific research departments: Telecommunications Technology and Remote Sensing; Materials and Structures; Energetics; Fluid Mechanics; Flight Mechanics/Guidance and Control. Test facilities include subsonic-to-hypersonic wind tunnels, rocket propulsion test stands, mobile launch facilities, spacecraft TTC stations and space simulators. For space missions, particularly those for Spacelab D2, Columbus and Eureca, DLR operates the Crew Training Complex, the Microgravity User Support Centre, the German Space Operations Centre, the Manned Space Laboratories Control Centre and the German Remote Sensing Data Centre.

II. INTERNATIONAL ACTIVITIES

A. Participation in the European Space Agency

Space research and space technology have been actively promoted in Germany since 1962. Western European countries were quick to recognize that space research could only be effectively conducted as a common European effort and in the context of international cooperation. For this reason they joined forces in 1964 in the foundation of the European Space Research Organization (ESRO) and the European Space Vehicle Launcher Development Organization (ELDO). These two organizations were merged in 1975 to create the European Space Agency (ESA) an organization whose activities are oriented to purely peaceful purposes. ESA has 13 member States and an annual budget currently amounting to almost 4.5 billion German marks. Germany makes the largest single obligatory contribution to this budget, with 23 per cent, on account of the size of its gross national product. Germany strives to maintain its own profile within the framework of close international cooperation and, apart from its role in ESA, is involved in bilateral and multilateral cooperation with such partners as the United States of America, but also Japan and the Commonwealth of Independent States.

German space objectives will continue to be realized through its participation in and, where appropriate, assumption of management responsibilities for programmes and projects in an international context, but particularly through its role in the drafting and implementation of ESA's long-term European space programmes. On the other hand, Germany places strong

emphasis on the national programme in order to ensure that the country has all the requisite competence and efficiency for full participation in international cooperation and in the utilization and application of the results of space research.

More than two thirds of Germany's space budget is channelled through programmes of the European Space Agency. German participation in ESA covers all important fields of space activities:

- Extraterrestrial science in the field of astronomy/astrophysics and solar-terrestrial relations with the disciplines aeronomics (physics of the higher spheres) and the physics of magnetospheres and plasma;

- Research under space conditions for material science, biology and medicine with manned and unmanned space-flight operations;

- Earth-oriented research with regard to the management of natural resources, the atmosphere, the oceans and the ice-covered areas of the Earth;

- Development of broadcasting-, telecommunication- and navigation-satellite systems;

- Research on orbital and terrestrial infrastructure, particularly space transportation systems, orbiting systems and ground infrastructure;

- Preparatory work for the use of orbital systems as satellites, platforms and laboratories, amelioration of the Ariane carrier technology, development of basic technologies as well as exploration of the industrial and commercial uses of space technology.

The current programme will lead to a broadening of European space activities in that it envisages constant manned laboratory operations under space conditions through the contribution to the space station Freedom with the Columbus programme (under German leadership), the planned utilization of the space station Mir of the Commonwealth of Independent States, the development of enhanced transport capacity and the projected data-relay satellite system.

The following are examples of major German participation and contributions to ESA programmes of current relevance.

The comet probe Giotto is best known for the spectacular pictures it radioed back to Earth during its extremely close fly-by of Halley's comet in 1986, when the distance between probe and the comet was a mere 605 km. The optical camera instrument was provided by German scientists. The probe's main mission was to observe the nucleus of the comet by means of special cameras and to collect data on the coma, i.e., the envelope of gas and dust surrounding the nucleus. Since the successful completion of that mission,

Giotto has been in hibernation in an elliptic orbit around the sun, i.e., in a stand-by position. The probe was reactivated in February 1990 and its trajectory was changed to arrange an encounter with the comet Grigg-Skelljerup, which it passed on 10 July 1992. Again, outstanding data were sent to Earth and are currently being processed.

The solar satellite Ulysses was launched in October 1990 with the Space Shuttle, which transported the space probe to its point of departure on a flight trajectory which can only be achieved by means of powerful booster rockets and a sophisticated swing-by manoeuvre around the planet Jupiter - an orbit around the poles of the sun. The main objective of the mission is the scientific study of solar wind and the sun's magnetosphere, the analysis of interplanetary and interstellar gases and particles and the measurement of unified radio and plasma waves. German scientists provided several of the payload instruments and German industry figured as main contractor for spacecraft development.

The year 1992 started with a convincing example of broad international cooperation in the field of space science, with the Spacelab IML-1 (International Microgravity Laboratory) mission. Germany participated in this multinational flight with contributions to ESA instruments as well as with national experiments in material and life science. Furthermore, IML-1 was the second flight of an ESA astronaut of German nationality.

One of the outstanding events of 1992 was the launch of the European Retrievable Carrier (EURECA). The objective of the EURECA programme is to employ a free-flying reusable research laboratory for long-term missions. Besides its utilization for experiments in the fields of life science and crystal growth under microgravity conditions (all of them being part of any exploitation of in-orbit infrastructure), the programme allows Europe to gain experience in operation and exploitation of orbital infrastructure. Launched in July 1992 by the Space Shuttle and put into low Earth orbit, EURECA's propulsion systems lifted the platform into a higher orbit, from which it will return to the Shuttle orbit after six to eight months, and from which it will be captured by the Shuttle and taken back to Earth. Germany is participating in this mission with 18 experiments, studying various effects of microgravity, vacuum and cosmic rays on material and biological probes. Germany is the system leader in this programme and contributes 51 per cent to the total financing.

In the area of Earth observation, the success of the European Remote Sensing Satellite (ERS-1) must be highlighted. This satellite was built under German system leadership. It is operational under all weather conditions and allows measurements with its microwave or, respectively, radar sensors through cloud layers both day and night. ERS-1 is dedicated to research in oceanography and ice observation, and its data gathered up to the present afford new and valuable inputs to global climate change models by describing the interactive relations between the atmosphere and the oceans.

The weather satellite Meteosat represents a classic example of the application-oriented utilization of space research. This system, which was developed within the ESA programme with German participation, is part of an internationally coordinated satellite-observation programme in the field of meteorology involving American, Japanese, and European satellites and systems of the Commonwealth of Independent States. A shining example of international partnership lies in the fact that the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) moved its spare satellite Meteosat-3 from his original position to a new position farther west in order to close a gap which was opened by the failure of the American weather satellite Geos-W.

Since 1978, ESA has had a telecommunication satellite presence in the geostationary orbit around the Earth with its experimental Orbital Test Satellite (OTS) satellites and, subsequently, with its pre-operational European Communication Satellite (ECS) and Maritim ECS (MARECS) satellites that have given Europe independence in the vitally important sector of telecommunications. Today, with its Olympus satellite and by studying advanced telecommunications systems, ESA is taking a hand in shaping the telecommunications of the future. Germany has 30 years of experience in this special field of space utilization and participates in the ESA telecommunication projects with important technology contributions.

In the framework of the European Long-term Space Programme, Germany puts particular stress on participation in the Columbus space infrastructure programme. The Columbus Attached Pressurized Module element will be a manned laboratory, constituting the European contribution to the International Space Station, and is being developed under German system leadership. The 1992 foundation of the Eurocolumbus company, a joint venture between German and Italian industry, will guarantee Germany's eminence in this field.

B. Participation in the United Nations

1. United Nations Committee on the Peaceful Uses of Outer Space

Germany has,since its accession to the United Nations, actively participated in the work of the United Nations Committee on the Peaceful Uses of Outer Space. During the 1980s and up to the most recent session of the Committee, the principle emphasis was placed upon the development of principles relevant to the use of nuclear power sources (NPS) in outer space. Together with Canada, numerous working papers were prepared for the sessions of the Committee and finally, in 1992, a consensus was reached in this field.

This activity indicates Germany's willingness to take the lead in arriving at standards from which mankind will benefit as a whole in that they aim, in this particular case, to prevent the harmful effects of the use of NPS. Another area where this principle of responsibility for mankind's natural environment is the core of German efforts is the control of the space debris problem. For several years the German delegation in the Scientific and

Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space has provided the other delegations with detailed information concerning research on space debris undertaken in Germany. The goal is to reach a consensus on preventive measures for controlling and minimizing space debris. Such an agreement would have, like the NPS principles, significant effects on the prospects for humankind's future peaceful use of outer space.

2. United Nations Programme on Space Applications and other training and fellowship programmes

Within the framework of this programme Germany hosted the Third United Nations Training Course on Remote Sensing Applications to Geological Sciences at Berlin and Potsdam in October 1991. Twenty geologists from 18 mainly developing countries attended the course. Germany intends to contribute further to the Space Applications Programme by continuing its support of this series of courses. Thus the fourth course in the series will be held from 28 September to 16 October 1992 in Germany in cooperation with the European Space Agency. Not only as a sign of German commitment to disseminating knowledge in the area of space applications, especially to developing countries, but also as a practical measure to enhance participation in space programmes from those countries, Germany plans to hold the course in the various economic regions of the world from 1993 onward.

Complementary to these activities, Germany welcomes the plans to establish regional Centres for Space Science and Technology Education in developing countries. A German expert will participate in the evaluation mission to Africa, which is scheduled to take place in early 1993.

Besides German participation in United Nations activities, various other training and fellowship programmes relating to space applications exist at German institutions. DLR accommodated 138 foreign research scientists for under three months and 91 for over three months in 1991. The Agency for Technical Cooperation (Gesellschaft für Technische Zusammenarbeit (GTZ)) hosted, inter alia, 15 training programmes abroad on remote sensing for eight participants each and invited 6 scientists to conduct research work in Germany for up to three months in 1991. The German Academic Exchange Service (Deutscher Akademischer Austauschdienst (DAAD)) awarded 27 fellowships for training in Germany in the areas of air and space medicine, aerospace science and technology. The Alexander von Humboldt Foundation awarded 5 fellowships in 1991. The Technical University at Braunschweig offers a complete training programme in space technology at the Institute for Space Flight Technology and Nuclear Reactor Technology. As is the case with other German universities, tuition is not charged. The University of Cologne offers a postgraduate doctoral programme to lawyers at the Institute for Air and Space Law, which is the oldest specialized institute of its kind in Europe. The programme is also open to lawyers holding foreign law degrees. Upon request, the doctoral examination can also be held in English.

All these programmes, even though they may not involve the United Nations Programme on Space Applications, parallel its activities in that they offer training opportunities which are open to researchers and scientists from developing countries.

3. German contributions to International Space Year

The German engagement in International Space Year (ISY) is motivated by the growing political and public determination to preserve the environment and to develop means of monitoring a large variety of oceanic, land-surface and atmospheric parameters. Public awareness of valuable contributions from space research in that context must be enhanced. The German ISY activities range from promoting multidisciplinary application projects (like atmospheric research, ice monitoring and warning for ships, land use mapping, vegetation monitoring, upgrading space data in geographical information systems) to sensor development, education activities and bilateral manned space missions.

The winter of 1992 saw extended balloon and aircraft measurement campaigns as part of the European Arctic Stratospheric Ozone Experiment, the results of which will be revealed during a workshop in Germany in October 1992. It also saw the maiden flight of the Millimetre-wave Atmospheric Sounder during the Atlas Shuttle mission in March 1992. With its mobile antenna system, the stratosphere and mesosphere were scanned at altitudes ranging from 10 km to 100 km and at latitudes of +/- 74°. It measured the millimetre-wave radiation emitted by the atmosphere at 61 GHz, 63 GHz, 183 GHz, 184 GHz and 204 GHz. The temperature and pressure profiles, as well as the volume mixing ratios of water vapour, ozone and chlorine monoxide could be calculated with high accuracy on the basis of the acquired data.

The major ISY event in Europe was the European ISY Conference, "Space in the Service of the Changing Earth", held at Munich from 30 March to 4 April 1992. It was organized jointly by the Commission of the European Community, ESA and DARA with strong sponsorship of other space agencies of ESA member States. After the successful completion of this first of the world's leading ISY events the following conclusions can be drawn: Earth observation from space was in the focus of interest from both participants and media. The preset aims, consisting mainly of the demonstration of the capability of European space technology for environment monitoring and attraction of the young generation were achieved; the capabilities and performance of the ERS-1 especially received much attention. A dialogue with other space disciplines took place.

High-ranking European and German politicians (President, Chancellor, Vice-President of the European Commission, and Ministers) made written or oral statements to the conference, emphasizing primarily the application of space technology to the solution of problems of planet Earth. The conference attracted some 1,500 participants. Special financial support programmes by the organizers enabled a substantial participation from developing countries

and Eastern European countries. Altogether almost 60 countries participated, and 535 papers and 120 posters were presented. One of the major impulses set out from the scientific community at the conference addressed the new organization of remote sensing satellite data utilization in Europe.

The ancillary events of professional and public exhibitions, a film festival, a forum for teachers and other multiplicators, a social programme with visiting tours, cultural receptions and a laser show attracted a total of 30,000 persons. Also, in the public relations domain, the possibilities for satellites to detect and monitor global climate change parameters were of prime interest and were broadly acknowledged.

Lessons were learned not only about political priorities in future space programmes, as triggered by the conference, but also during the practical attempts to enlarge the spectrum of space data utilization through joint pilot and demonstration projects with administrations other than of research and technology. It turned out that ISY was a vehicle to enhance the interest of administrations in the potential of these data, e.g., in the areas of environment, transport, survey, agriculture and forest, but they are still very sceptical as to the costs of such programmes. Co-sponsoring by these partners always included the expectation that cost/benefit ratios could be elaborated or that a new characteristic of the service could clearly be identified.

An example from forest inventory lies in the fact that large areas can be observed in a given time rather than drawing statistical conclusions from a small probe. Furthermore, the possibilities of superposing information on different areas in a Geographic Information System to investigate causal relationships and, in turn, of enabling corrective actions, gives reason for interest in the area of applications. As was stated at the conference, much more attention must be devoted to data utilization, and future sensor development must always be accompanied by a profound application concept.

III. ACTIVITIES IN THE NATIONAL SPACE PROGRAMME WITH BILATERAL OR MULTILATERAL SCOPE

As with many other nations, Germany's space programme has its roots in space science endeavours centring on an extensive sounding rocket activity beginning in the early 1960s. With Germany's participation in the European cooperative programmes of ESRO and ELDO, the predecessors of ESA, the perception evolved that a reasonable national programme would be a necessary accompaniment to international efforts. However, almost no purely autonomous activities were either planned nor executed. As was briefly mentioned in the introductory remarks above, German space activities have from the beginning been concentrated on international cooperation. Thus, Germany's first scientific satellite Azur was launched by the United States National Aeronautics and Space Administration (NASA) in 1969. Since then, a series of national projects has been executed in cooperation, primarily, with the United States and France, but also with other European countries such as Sweden,

Italy, the Netherlands, the United Kingdom of Great Britain and Northern Ireland and others. Partnership with the Commonwealth of Independent States and Japan is currently being intensified. Of special note is the fact that the space projects carried out jointly between the former German Democratic Republic and the former Soviet Union have been taken over to a certain extent by the German Government after reunification and have now been incorporated into an already existing agreement of cooperation between Germany and the Russian (former Soviet) Academy of Sciences. This agreement comprises about 50 projects in the different disciplines of space research and technology.

A large number of bilateral agreements on scientific and technical cooperation constitute the legal groundwork of German activities in space, including with such developing countries as Argentina, Brazil, China, India and Indonesia, among others.

Germany's space activities have been directed from the outset by the Federal Ministry for Research and Technology, the Bundesministerium für Forschung und Technologie (BMFT), or its predecessors. Other BMFT-funded institutions dealing with space research are, e.g., the German Aerospace Research Establishment (DLR), the German Science Foundation (Deutsche Forschungsgemeinschaft (DFG)) and the Max-Planck Society (Max-Planck-Gesellschaft (MPG)). A major organizational change occurred in 1989 with the above-mentioned creation of the German Space Agency DARA, which assumed responsibility for the planning and the management of Germany's national and international space programmes and for the representation of Germany's space interests in international relations, particularly regarding ESA. The national element of the space programme is conceived in particular to supplement the participation in ESA programmes and to prepare German industry and scientific institutions for special domestic research and development and utilization demands as well as in order to maintain a competent role in European and other international programmes. National planning is in conformity with ESA's long-term plan covering up to the early years of the next century and with the Government's current medium-term financial plan, covering a five-year period, up to 1996.

At present, the balance, in financial terms between the national programme (which includes funding of DARA and partial funding of research establishments but excludes the Hypersonic Technology Programme) and Germany's contribution to ESA programmes has been set with ESA programmes absorbing an average of 65 per cent of the total space expenditure, thus indicating Germany's conception of space issues as international cooperative endeavours. The proposed total annual expenditure averages about DM 1,830 million (period 1992-1996), including national budgets averaging DM 630 million per year.

The most significant programmes covered by the national plan can be summarized as follows:

Space science

The extraterrestrial basic research programme of the German Government comprises projects of astronomy/astrophysics and solar-terrestrial relations, with the sub-areas of aeronomy, magnetospheric and plasma physics as well as planetary and cometary physics. The objective of this programme is the continuous promotion of space science in Germany through a national programme, through participation in the ESA space science programme and in bilateral projects as well as support of in-house initiatives of the research institutes.

The well-balanced mixture of short- and long-term activities takes account of the special structure of the German scientific community. Besides most of the national, international and ESA projects with their comparatively long durations, special attention is given to short-duration sounding rocket programmes and the use of Space Shuttle compatible reusable platforms (ASTRO-SPAS) for the training and the teaching of junior scientists at university institutes. A primary characteristic of all activities is their contribution to the acquisition of new findings in basic research.

In the area of atmospheric physics, efforts are being made to study and understand the structure and dynamics and the energy budget of the Earth's atmosphere. For this purpose mainly sounding rockets (e.g., Dyana) are used, but also satellites and platforms (e.g. CRISTA-SPAS). Special scientific goals are in situ measurements of the upper and middle atmosphere.

The main emphasis of future planetary and cometary research will be on in situ investigations and return of material samples to Earth (CASSINI/HUYGENS, CNSR). Preferred objects of observation will inclulde the planets Mars, Jupiter and Saturn with their moons, as well as asteroids and comets.

In the last few years, astronomy has been a key area of extraterrestrial research. Besides specific instruments (e.g., ORFEUS-SPAS, GAUSS/D2), the tendency to operate new observing systems (HST, Rosat, GRO, ISO, AXAF, XMM) will grow. Observations will cover a wide frequency spectrum, ranging from radio waves to gamma-rays. High-energy processes (quasars, black holes) as well as areas of new stars' birthplaces, large-scale structures, the big bang and other cosmological aspects will be of primary scientific interest. The scientific output will depend decisively on coherent long-term investigations in all areas of the electromagnetic spectrum, and between space-borne and ground-based observatories.

The national programme is concentrated on the supply of instruments for the multitude of scientific activities and on the supply of additional flight opportunities through participation in international projects such as the Hubble Space Telescope, through national long-term projects such as the X-ray satellite Rosat, through bilateral long-term projects such as the Galileo mission to Jupiter and through the realization of short-term missions, e.g. with sounding rockets and platforms (ASTRO-SPAS).

Earth observation

Reflecting its enhanced priority within the German space programme, the budget for Earth observation will increase remarkably within the coming years. The national Earth Observation programme is divided into contributions to national and multilateral projects, and to projects within the framework of European organizations such as ESA, EUMETSAT and the European Economic Community. The German national effort is oriented to providing equal emphasis to scientific research and operational applications and specific utilization. It is designed to be complementary to the ESA Earth Observation programme, but concentrates on projects of high interest to the German scientific and user community. Currently, active projects centre on instrument development, flights and data exploitation. There is a need for a broadly defined European and international policy in this field. Important projects are PRAREE for POEM-1 (in cooperation with Sweden), the microwave sounder MAS as a contribution to five of the American Atlas missions, X-SAR (in cooperation with Italy) as a contribution to three Shuttle missions with the SIR-C of NASA, the scanning radiometer instrument ScaRaB (in cooperation with France) to be flown on the Russian Meteor satellite, the opto-electronic scanner spectrometer MOS and the high-resolution multispectral camera MOMS-02 on-board the Priroda module which will be attached to the Mir space station in 1993.

Research under space conditions

Major projects of the German programme on research under space conditions, especially in the field of microgravity research for material and life sciences and processing technology are the national Spacelab missions D1 and D2 and the international missions IML-1/-2 and E1, flight opportunities on Mir and the fully automated flight platform of EURECA. Focal points of the national programmes are preparatory laboratory research and short-term flights, such as drop towers, parabolic flights, sounding rocket flights (Texus/Maxus) and balloon flights (Mikroba). The participation in the multilateral IML-1 mission in January 1992, the highly successful flight of a German astronaut on board the Mir space station in March 1992 and the planned flight of the national Spacelab mission D2 (in cooperation with NASA) mark three milestones in Germany's long history of activities in the field of microgravity research. It is expected that big projects in microgravity research on an almost purely national level will end with the Spacelab mission D2. Subsequently, projects of this kind will be seen as cooperative programmes both for development and flight. Increased emphasis is put on the use of Mir as, for example, a good focus for a space medicine programme with a relatively short lead time.

Telecommunications/navigation

The German national programme concentrates on future basic and user-oriented developments and pilot projects in the fields of mobile communications, broadcasting and navigation services. High priorities are given to technologies which allow for reduced consumption of power and frequencies, and economic production techniques.

Important projects in the time frame until 1995 are the development of controllable planar antennas for mobile communication via geostationary and other satellites and the enhancement of the communication infrastructure in Eastern Europe by involving satellites. Focal points are studies and analyses on user needs and system requirements, as well as the development of small Earth communication spots (V-SAT) and the development and testing of an optical communication system (SOLACOS) with lasers for high data rate communication between satellites. With respect to a field of special public and commercial interest - satellite navigation, - a demonstration project on the use of a differential GPS for precise applications is foreseen.

Studies and technology

Germany's national programme comprises a programme line which deals with new basic and applied technologies and with strategic studies. Projects of this line are aimed to support the larger space programmes by accompanying technology studies and technology development and demonstration projects. Efforts in the field of new technologies will render future projects possible and support the ongoing programmes. Furthermore, funding is made available for small and medium-size companies to support their specialized engagement and to contribute to their efforts in commercializing developed technologies and products. Another comprehensive task of this programme line is to apply product assurance for space projects. Worthy of mention are the strategic studies carried out in order to provide a rational basis and sound back-up for Germany's space plans and policy.

Orbital infrastructure

In this area, national resources are concentrated on in-orbit servicing (mainly automation and robotics and rendezvous and docking), on small satellites, a small capsule for tethered re-entry and a limited effort for technology developments related to orbital and transport systems and re-entry.

Hypersonic technology programme

Activities of this programme are still directed by BMFT. Since its commencement in 1988, some DM 300 million have been made available over a four-year period. Industry has contributed some 30 per cent of the total sum. The so-called Sänger configuration concept is used as guideline for technological feasibility studies and development. An interim report is currently under preparation. Four main areas of technology have been studied: propulsion, aerothermodynamics, structures and materials, and navigation and control. A "Europeanization" of the programme is intended and a decision will be made in the near future after discussion with ESA member States interested in the subject.

Ground facilities

As a result of the evolutionary process and Germany's engagement in space activities and programmes, a significant national ground infrastructure

already exists in the fields of test and operational facilities. The following are only a few examples, as a complete listing of all German facilities would be too extensive: the German Space Operations Centres (GSOC) at Oberpfaffenhofen; data transmission ground stations at Weilheim; various rocket engine test facilities at Lampoldshausen; wind tunnels, astronauts education and training facilities and large-scale test facilities at Munich; as well as various specialized laboratories. Other ground facilities which are in line with European activities, particularly to serve the envisaged orbital space infrastructure, are under construction.

GREECE

[Original: English]

With a view to promoting greater international cooperation, the competent Greek authorities propose the study of satellite applications related to the prevention of national disasters with particular emphasis to the use of very small aperture terminals. Furthermore, they see interest in discussing, within the framework of the Committee on the Peaceful Uses of Outer Space, issues pertaining to the know-how of techniques used for pattern recognition of satellite-transmitted images.

HUNGARY

[Original: English]

This report summarizes those Hungarian space activities in 1992 that were/are the subjects of greater international cooperation in the Hungarian space programme and activities, giving the partners and spin-off benefits. We also consider those areas which could be the focus of further international cooperation as well.

In 1992 there were deep changes in the Hungarian space activities, given the peculiar circumstances of the year. As of 31 December 1991, the Hungarian Intercosmos Council had finished its work, after decades of successful activity with invaluable results. On 1 January 1992, a new Hungarian Space Organization was established, which continues the active participation in international cooperation. This entails international collaboration with the Eastern European republics, with Central European countries (Central European Initiative (CEI)) with the Western European countries (ESA) and initiating new cooperative ventures with overseas countries, first of all with NASA.

In connection with international cooperation, it should be mentioned that after more than two decades (in the Intercosmos programme) we worked hard in 1992 to continue the previous cooperative arrangements and to establish new arrangements as well.

We recognized the changing role of regional cooperation among the small- and medium-sized countries which are becoming increasingly important, not only in Central Europe but throughout the world. We are a member of CEI and we participate in three missions (CESAR; the CEI remote sensing mission; the LEO microgravity mission) which were adopted by the CEI member countries.

After the establishment of the new Space Organization in our country, the Hungarian Space Board made a series of decisions which altogether outlined a new policy in Hungarian space activities. Among the most important of these was our decision that Hungary, one of the smallest countries of the world, will carry out all our future space activities within the framework of international cooperation.

Although our space activities include many scientific fields of research and application, we report here only on internationally significant subjects which we deem worthy of emphasis and which could be the subject of further international cooperation.

Our response is grouped according to the Secretary-General's circular letter OOSA/96/003 listing the subjects of international cooperation with the partner countries and with the spin-off benefits, in order to show the main components of our space activities.

The main subjects of our international cooperation are as follows:

1. IN THE SPACE-EARTH SYSTEM AREA

The space-Earth system as a main direction for research and application (including such sub-areas as remote sensing, meteorology, the Earth observation, global change, etc.) was allotted the highest priority in the new Hungarian space programme. This top priority is justified by the direct scientific service of the creation and preservation of social values in our country. Such a priority is justified also by the possible international cooperation which we expect to receive from all European as well as overseas countries and by the possibilities open to one of the smallest countries, not only at present but in the future as well.

Our main cooperations in the space-Earth system area include:

1.1. Subject: Development of the Hungarian Remote Sensing Centre

Partner countries:

The Hungarian experts work together with experts from ESA (Paris) and with some institutes of the Central European countries.

Spin-off benefits:

We will utilize the benefits of this project in the Hungarian processes of creation and preservation of values first of all in agriculture, crop yield

forecasting, land-forest-water management; protection of the environment; cartography, etc.

1.2. Subject: CEI remote sensing mission

Partner countries:

The member countries of CEI: Italy, Austria, Poland, Czechoslovakia, Slovenia, Croatia.

Spin-off benefits:

We will use the benefits of this project in the Hungarian value-creating and value-preserving processes, in agriculture, land-forest-water management, protection of the environment, etc.

1.3. Subject: Photosynthetically active irradiation of the Earth's surface from satellite cloud observations

Partner country and institute:

United States of America, Department of Meteorology, University of Maryland.

Spin-off benefits:

- Increase of efficiency of Hungarian agriculture;
- Development of environmental science;
- Utilization of solar energy in Hungary;
- Improved recognition of climate dynamics;
- Increasing the scientific level of education.

1.4. Subject: Signal Analyser and Sampler (SAS), Wave Experiment on the Active Satellite

Partner countries and institutes:

- Russia, Institute of Cosmic Research, Moscow
- Russia, Institute of Physics of the Earth, Moscow
- Russia, Institute of Terrestrial Magnetism, Ionosphere and Radio Propagation, Moscow
- United States, NASA, Goddard Space Flight Center Wallops Flight Facility
- Czechoslovakia, Geophysical Institute, Prague

Spin-off benefits:

- Development of upper atmospheric science;
- Increasing the scientific level of education.

1.5. Subject: Participation in the INTERBALL programme

Partner countries and institutes:

- France, Centre Nationale Etude Spatiale, Paris
- Russian, Institute of Cosmic Research, Moscow

Spin-off benefits:

- Development of space-Earth science;
- Development of environmental science;
- Increasing the scientific level of education.

1.6. Subject: Pulsations in space and on the surface of the Earth

Partner countries and institutes:

- Germany, Technische Universität, Braunschweig; Institut für Geophysik und Meteorologie
- Italy, Universita del'Aquila
- Belgium, Observatoire royal de Belgique

Spin-off benefits:

- Helping the Hungarian value-creating and value-preserving processes;
- Development of space-Earth Science;
- Increasing the scientific level of education.

To summarize our participation in international cooperation in the space-Earth system area, we must emphasize that for us the most important aims are:

- Development of our remote sensing culture and, naturally, the use of the scientific results in the Hungarian value-creating and value-preserving processes;

- Research and application in the area of meteorology, Earth observation, etc., in order to help our economy (agriculture, land-forest-water management, protection of the environment, etc.);

and both are important for our contribution to scientific development.

2. IN THE SPACE PHYSICS AREA

In our order of priority of space activities space physics has been deemed to be second in importance, for we have such a well-established research basis, with the relevant knowledge, such valuable experiments (in the Intercosmos programme), such scientific results, etc., as to guarantee that we will be able to be a creative partner in all possible directions of international cooperation. Our main aims in this area are to participate first of all in the different international missions in which the lead country of the particular project judges us to be suitable for that cooperation (e.g., ESA, NASA, CEI, RSA, etc.).

We know full well that the research work and the scientific results in this area could not serve our economy and the Hungarian value-creating processes directly. The possible spin-off benefits lie mainly in the development of science and in increasing the scientific level of education.

Our main cooperation endeavours in the space physics area are:

2.1. Subject: Participation in the Phobos-2 mission (Data analyses, data processing)

Partner country and institute:

- Russia, Institute of Cosmic Research, Moscow

Spin-off benefits:

- Development of science;

- Increasing the scientific level of education.

2.2. Subject: Participation in the MARS-94 Mission (development of on-board software and ground equipment)

Partner country and institute:

- Russia, Institute of Cosmic Research, Moscow

Spin-off benefits:

- Helping the Hungarian value-creating processes (in both software and hardware);

- Development of science;

- Increasing the scientific level of education.

2.3. Subject: Participation in the Cassini mission (experiments, ground equipment and on-board software)

Partner country and institute:

- United States, NASA, Washington

Spin-off benefits:

- See 2.1. above

2.4. Subject: Participation in the Cluster mission (experiments, testing, ground equipment, data processing)

Partner countries:

- ESA, Paris

Spin-off benefits:

- See 2.2. above

2.5. Subject: Participation in the Central European Satellite for Advanced Research (CESAR) mission

Partner countries:

- Member countries of CEI (Italy, Austria, Poland, Czechoslovakia, Slovenia, Croatia)

Spin-off benefits:

- Development of knowledge of the Earth's magnetosphere

- Development of science

- Increasing the scientific level of education

2.6. Subject: Participation in the Spectrum-X-Gamma Research (development of on-board equipment)

Partner countries and institutes:

- Russia, Institute of Cosmic Research, Moscow

- United States, NASA, Washington

Spin-off benefits:

- See 2.2. above

To summarize our participation in international cooperation in the space physics area, it can be seen that we are concentrating all our possibilities mainly on the different missions. This conception has determined the spin-off areas as well, which are first of all to help the development of science and education.

3. IN THE LIFE SCIENCES AREA

Our international cooperation in the life sciences area had been very vital and wide-ranging for decades, and continued in the same way in 1992. We have more than 10 institutes (hospitals) which have special space/life science bases for research in different aspects of this area (weightlessness effects, vestibular-system, metabolism, brain/nervous system, etc.). In the past two decades we have created very close and wide-ranging cooperation with the institutes of Middle East and European countries participating in the Intercosmos programme. Since 1990 we have accelerated our search for possibilities for cooperating with West European and overseas bases.

The spin-off benefits from the life science area can be listed into three groups of main directions: medicine for the benefit of society; the development of science; and increasing the scientific level of education.

Our main cooperative endeavours in the life sciences area are:

3.1. Subject: Cerebellar and vestibular functions in flight

Partner country and institute:

- Russia, Institute of Cosmic Research, Moscow

Spin-off benefits:

- See the introduction to section 3 above

3.2. Subject: Gravitational effects on cellular level

Partner country and institute:

- Switzerland, Institute für Biotechnologie ETH, Zürich

Spin-off benefits:

- See the introduction to section 3 above

3.3. Subject: Quantitative analysis of the brain

Partner country and institute:

- United States, Laboratory of Neurophysiology, Department of Neurology, Baylor College of Medicine, Texas

Spin-off benefits:

- See the introduction to section 3 above

3.4. Calcium metabolism

Partner country and institute:

- Russia, Institute of Cosmic Research, Moscow

Spin-off benefits:

- See the introduction to section 3 above

3.5. Subject: Muscular system in flight (in weightlessness)

Partner countries and institute:

- Russia, Institute of Cosmic Research, Moscow

- Russia, Institute of Biomedical Problems, Moscow

Spin-off benefits:

- See the introduction to section 3 above

After renewing our cooperation arrangements with the previous Intercosmos countries and establishing new ones with Central/West European and overseas countries, we hope that in 1993 we will be able to outline a new conception and a new programme for our institutes in the life sciences area.

4. IN THE SPACE TECHNOLOGY AREA

Our research programme in the space technology area for 1992 was mainly determined by the conditions prevailing during the Intercosmos years. These conditions (e.g., flight and transport possibilities) changed greatly at the beginning of the current year, and delayed our participation in international cooperation, first of all in the subject area mentioned in section 4.2 below.

We are searching for new ways to continue our programme, and we hope that we can find them. We know full well that for such a small country as Hungary the space technology area can only be a good research direction if we are able to play the role of a creative partner in international cooperation.

Our main cooperative endeavours in the space technology area are:

4.1. Subject: Low Earth Orbit (LEO) microgravity mission

Partner countries:

- Member countries of CEI (Italy, Austria, Poland, Czechoslovakia, Slovenia, Croatia)

Spin-off benefits:

- Helping the Hungarian value creating processes (industry)

- Development of material (medicine) science education

4.2. Subject: Development of universal multi-zone furnace (on-board equipment)

Partner country and institute:

- Russia, Institute of Cosmic Research, Moscow

Spin-off benefits:

- See 4.1. above

4.3. Subject: Solidification of ternary solid solution

Partner countries and institute:

- Germany, University of Bremen; University of Darmstadt

- Russia, Institute of Cosmic Research, Moscow

- Canada, Queen's University, Kingston, Ontario

Spin-off benefits:

- See 4.1. above

ISRAEL

[Original: English]

The following Israeli space activities could be the subject of greater international cooperation:

1. The Ofeq mini-satellites (~160 kg - three-axis stabilized) could be used for a variety of medium-size and small scientific payloads. These satellites were proven to be space-qualified in two launches.

2. The Amos communication satellite is presently under construction.

3. A micro-satellite (~50 kg) is currently being built. Small scientific payloads would be launched on board this satellite. International cooperation is welcomed.

4. An ultraviolet telescope is currently being built, for launching as part of a Danish experiment on board a Russian satellite. The current Israeli-Danish-Russian cooperation can be expanded.

5. An X-ray telescope is being built, to be lifted by an Italian balloon next year. International cooperation is welcomed.

6. Israel cooperates in the image processing of the Mars-94 pictures. International cooperation is welcomed.

7. The laser tracking system near Jerusalem is providing positioning within about 2 cm as part of the global plate tectonics programme. Additional international cooperation is welcomed.

8. Multispectral studies of ground reflectance (albedo) of desert, semi-arid and arid zones as well as desertification and de-desertification are currently being carried out. Additional international cooperation is highly desirable.

ITALY

[Original: English]

I. ITALY'S SPACE POLICY

For many years Italy has devoted great attention to space activities which are considered very important in order to foster new research, to support modern industrial development, to develop advanced technologies and to promote international cooperation.

National and international space activities in Italy have been managed and funded since 1988 via the Italian Space Agency (ASI), which is the instrument for implementing space policy for the Italian Government and for the Ministry for University and for Technological and Scientific Research (MURST). The Italian universities and the National Research Council (CNR), as well as industries, are also involved in space activities.

The policy that is being followed is determined by the Interministerial Committee for Economic Planning (CIPE), through the approval of the framework of a five-year space plan, prepared by ASI and presented by MURST. The plan includes the development of national programmes as well as the participation in the activities of the European Space Agency (ESA). Bilateral agreements in this area of cooperation are in force with many countries, including Argentina, France, Germany, Japan, Kenya, the Netherlands, Russia, the United States of America, the Central and Eastern European countries, etc.

The annual budget of ASI is about Lit 1,000 billion (US$ 800 million), of which 15 per cent is for basic scientific research. In support of the goal of international cooperation, half of the ASI budget is directed via the European Space Agency (ESA).

II. MAJOR NATIONAL PROGRAMMES

Major national programmes include:

Italsat

The Italsat programme has the aim of producing a telecommunication satellite that will work exclusively with digital technologies and will afford operational solutions for the 1990s in pre-operational form. Communication links within the programme will be established using new frequency bands in the higher parts of the spectrum (20-30 GHz), where large numbers of channels are still available. The Italsat mission will develop and make use of advanced technologies such as multiple-beam antennas, the use of radio-frequency sensors for high-precision pointing of antennas, signal boosting and communication aboard the satellite, an integrated propulsion system for the apogee engine and for controlling the trim of the satellite, etc. Italsat was launched with Ariane IV in January 1991.

Tethered satellite system (TTS)

This is a programme of collaboration with the United States of America (NASA) and concerns the production of an integrated system made up of three basic elements, namely the deployer, the trailing satellite and the tether, an element that connects the former two and may attain a length of 100 km or more. This system permits scientific measurements and technological missions to be carried out at a distance of up to 100 km from the Space Shuttle, as well as above and below it.

Possible applications include atmospheric or ionespheric experiments, to study aerodynamic problems that derive from the interaction between satellites and the upper atmosphere and to determine important geophysical parameters; and electrodynamic experiments concerning the interaction of the system with the terrestrial magnetic field and with the plasma of the Earth's magnetosphere, in order to verify whether a conducting tether could be used for the production of electric energy and whether it is possible to develop a new method of electric propulsion. The first TTS-1 mission was carried out in July 1992.

Lageos II

Lageos II, a cooperative programme with the United States of America (NASA) for the development of a second geodetic satellite to improve the performance of the world system for measuring the motion of the Earth's surface, will be launched by the NASA shuttle in October 1992. The first Italian laser ranging station, situated near Matera in southern Italy, will form part of the world-wide network of about 20 stations in all parts of the globe, which will be involved in laser measurements.

SAX (X-ray Astronomy Satellite)

SAX is a cooperative programme with Holland (NIVR) for the design and development of an X-ray astronomy satellite which will explore the universe in the radiation bands between 0.1 and 200 Kev. In this region of the spectrum it will be possible to study many phenomena that characterize the violent evolution of star systems and galaxies. It is foreseen that the satellite will be put into orbit in early 1994 by an Atlas launcher.

IRIS

The Italian Research Interim Stage (IRIS) programme has the goal of fabricating an auxiliary propulsion stage for launching satellites, in the weight range of 600-900 kg, from the Space Shuttle in geo-transfer orbit or in a different energy orbit. The launch is planned for October 1992.

SAR X (X-ray Synthetic Aperture Radar)

Among the activities aimed at improving the remote sensing capability, Italy (ASI), together with Germany (DLR) and the United States of America (NASA), is carrying out the development of an X-ray synthetic aperture radar to be flown on board the Shuttle as part of the SIR-C mission for multispectral radar observation. The simultaneous observation of the Earth's surface, at multiple angles of incidence with three frequencies (1.3, 5.3 and 9.6 GHz), will provide radar images with different signatures from the same target scene. Thus the X-band SAR, in combination with the two-frequency SIR experiment, represents a new step towards multispectral/dual polarization SAR measurements from space. The first mission is planned for October 1993.

III. EUROPEAN SPACE AGENCY PROGRAMMES

Italy, as State member of ESA, participates, in the framework "Horizon 2000", in mandatory ESA scientific programmes. Noteworthy among these are the Infrared Space Observatory (ISO), the Solar and Hellospheric Observatory (SOHO), the Huygens probe of the ESA-NASA Cassini mission, the International Ultraviolet Explorer (IUE), Hipparcos, which is aimed at star-mapping, and Giotto.

The Italian contribution to ESA optional programmes is also of importance, especially in the areas of space transportation systems (Ariane IV, Ariane V and Hermes), Earth observation (ERS-1 and the Columbus Polar Platform), telecommunication (Olympus, Data Relay Satellite (DRS), TM Artemis, Apollo/Diana, and Advanced System and Technology Programmes (ASTP) 3 and 4), and in-orbit infrastructure (Columbus with the Attached Pressurized Module (APM) and Microgravity).

IV. FUTURE SPACE ACTIVITIES

The other major national activities foreseen in the current Space Plan in the near future are:

- Mini-pressurized Module, to be developed under a bilateral ASI/NASA agreement in the framework of the International Space Station programme;

- ASI/NASA cooperation in the Cassini interplanetary mission;

- Development and launch of a second communication satellite (Italsat II), development of a new launcher for small satellites in low-energy orbit (modified Scout) and development of small Earth observation and scientific satellites;

- Development of an autonomous inspection and repair robotic vehicle system (Spider);

- Development of a technology re-entry capsule for microgravity experiments (Carina).

LUXEMBOURG

[Original: French]

The space activities of the Grand Duchy of Luxembourg are limited to the operation of a satellite system for the transmission of television and radio programmes by a private concern, which provides this service on a commercial basis under a concession granted by the Government.

The Société Européene des Satellites, S.A., currently operates two space segments, each having 16 transponders and together transmitting about 30 television programmes and a rapidly growing number of radio programmes. There are plans to put a third satellite in orbit in 1993, a fourth in 1994 and a fifth in 1995. The company is at present considering a further expansion of the system.

The satellites, known as Astra, have developed direct television reception of satellite transmissions throughout Europe. Around 40 million households receive their signals, accounting for approximately one quarter of the inhabitants of Western Europe.

All the Astra satellites are stacked in the same orbital position at 19 degrees East. The number of television programmes currently available is 32 and will rise to 80 in the future. The system carries the programmes of both public and private broadcasters. The programmes are transmitted using the different transmission systems and in different languages, some of them in several languages at the same time.

The signals of the Luxembourg satellite system cannot be received on other continents, with the exception of the Mediterranean seaboard of North Africa.

SWEDEN

[Original: English]

I. NATIONAL ORGANIZATION OF SPACE ACTIVITIES

The Swedish National Space Board, under the Ministry of Industry and Commerce, is the central governmental agency responsible for the Swedish national and international space and remote sensing programmes. For the research programme the Board receives funds from the Ministry of Education and Science. The responsibilities of the Board include:

(a) Initiating research, development and other activities connected with the Swedish space and remote sensing programme;

(b) Coordination of Swedish activities within the fields of space technology and research as well as remote sensing;

(c) Distribution of government appropriations for Swedish space activities;

(d) Authorization and supervision of space activities in accordance with space law;

(e) Maintaining contacts with international organizations and institutions operating within the field of space activities and remote sensing.

The Board has three advisory committees: for industrial policy, science (including microgravity) and remote sensing, respectively.

The technical implementation of the national space and remote sensing programmes are mainly contracted by the Board on an annual basis to the State-owned Swedish Space Corporation (SSC). The principal responsibilities of the Swedish Space Corporation are:

(a) The technical implementation of the Swedish space and remote sensing programmes;

(b) To conceive, specify and procure satellites for applications and space science research;

(c) To operate the Esrange sounding rocket range and satellite control/reception facilities;

(d) To perform system management and engineering for complex high-technology projects;

(e) To receive image data from remote sensing satellites at Esrange, and to process and analyse such images into map products for customers throughout the world (SSC Satellitbild);

(f) To develop and supply operational remote sensing systems for maritime surveillance and environmental control.

II. MANNED SPACEFLIGHTS

Sweden participates in manned space activities within the European Space Agency (ESA). One of the astronauts in the European Astronaut Corps is a Swede.

III. SPACE APPLICATIONS PROGRAMMES

A. Remote sensing of Earth resources and environment

The past years have been characterized by the development and consolidation of remote sensing activities in Sweden. New, advanced equipment has been made available through *in situ* development, through purchase or through international cooperation. Several major cooperative field experiments have been carried out the objective of which is to assess the potential of the technology for various applications, but above all to acquaint the potential users with the available technology at an early stage.

In 1992 Sweden contributed to the International Space Year project entitled "World Forest Watch".

The Esrange facility, which has been receiving and processing Landsat data on behalf of ESA since 1978, receives SPOT data on behalf of the Centre National d'Etudes Spatiales (CNES), France. Data are also regularly received from the polar orbiting satellites MOS (Japan), and on an experimental basis data have been received from Resurs and Okean (Russian Federation). There is an agreement with ESA to receive and process ERS-1 data. A separate ESA facility has been established for that purpose at Salmijärvi (near Esrange).

SSC Satellitbild in Kiruna is processing and distributing SPOT data in cooperation with the French company SPOT Image. SSC Satellitbild specializes in providing geometrically precision-corrected SPOT and Landsat data for the world market.

Sweden cooperates with France on the SPOT remote sensing satellite system, and the Kiruna facility is one of the two principal stations in the SPOT network.

Sweden participates in the ESA programme for receiving, pre-processing, archiving and distribution of images from remote sensing satellites (Earthnet). The Swedish ground station at Esrange, Kiruna, forms part of the system and is collecting Landsat data on a routine basis. The Swedish Space Corporation is the National Point of Contact.

Sweden also participates in the remote sensing programmes of ESA such as the programme for development of remote sensing satellites (ERS-1 and ERS-2) and the Earth observation preparatory programme.

B. Meteorology

Cloud cover photographs and other meteorological data from ESA, United States and Russian weather satellites are received regularly by the High-Resolution Picture Transmission (HRPT) and Automatic Picture Transmission (APT) stations of the Swedish Weather Services and are used in weather forecasting.

A project concerning the establishment of short-term weather forecasting and regional weather service based on advanced space and remote sensing techniques, including weather radar, SODAR, microwave radiometry and weather satellites, has entered into an operational phase.

Developmental work is continuing on the operational use of advanced digital image analysis of polar weather satellite data. A microwave radiometer for the sounding of temperature and humidity of the atmosphere has been developed for operational use.

C. Communications

Sweden participates in the communications programmes of ESA such as the ECS programme, the advanced systems and technology (ASTP) programme, the payload and spacecraft development and experiments (PSDE) programme and the data relay satellite (DRS) programme.

On a national level, the Swedish Space Corporation operates the Tele-X telecommunications satellite system. Tele-X provides the following services:

(a) High-speed digital data and video communications, 64 kbit/s-2 Mbit/s, using small Earth stations;

(b) Direct TV broadcasting to small (30 cm diameter), home receivers.

D. Navigation

Satellite navigation equipment is in routine use on Swedish merchant vessels using Transit-type satellites.

IV. NATIONAL SCIENTIFIC SPACE PROGRAMMES

The main scientific activities of the Swedish research groups are:

(a) Magnetospheric and ionespheric physics, in particular measurements of charged particles and electric and magnetic fields using satellite experiments, sounding rockets and balloons;

Groups: Swedish Institute of Space Physics, Kiruna

Swedish Institute of Space Physics, Uppsala Department of Plasma Physics, Royal Institute of Technology, Stockholm

(b) Study of the upper atmosphere (80-150 km), in particular atmospheric processes and composition at high latitudes using sounding rockets;

Group: Institute of Meteorology, Stockholm University

(c) Astrophysics, in particular, studies of solar and stellar UV radiation and IR studies using satellites, sounding rockets and balloons in international cooperation;

Groups: Lund Observatory, University of Lund

Stockholm Observatory, University of Stockholm

Uppsala Astronomical Observatory, University of Uppsala

Onsala Space Observatory, Chalmers

University of Technology, Gothenburg

(d) Materials sciences, in particular, solidification processes of metals, diffusion processes in liquid metals and crystal growth in microgravity using sounding rockets;

Groups: Department of Casting of Metals, Royal Institute of Technology, Stockholm

(e) Life sciences, in particular, studies of human physiological processes in microgravity;

Group: Department of Baromedicine, Karolinska Institutet, Stockholm

(f) Biophysics, in particular, electrophoretic and protein crystal growth studies in microgravity;

Group: Department of Physical and Inorganic Chemistry, Chalmers University of Technology, Göteborg

(g) Remote sensing, in particular, microwave radiometry, spectral signatures and image analysis using satellite images and registrations from airborne or land-based sensors;

Groups: Department of Radio and Space Science, Chalmers University of Technology, Gothenburg

Remote Sensing Laboratory, Department of Physical Geography, University of Stockholm

Remote Sensing Laboratory, Department of Physical Geography, University of Lund

Department of Physics, Lund Institute of Technology

Remote Sensing Laboratory, Swedish University of Agricultural Sciences

(Note: several groups are engaged in research concerning remote sensing; only the largest and most active groups are listed above. Details on the activities are given in "Space Research in Sweden", published biannually for the COSPAR meetings.)

A. Satellites

1. Viking - Sweden's first satellite

Viking was launched by the Ariane V-16 rocket from Kourou on 22 February 1986. Its lifetime, originally designed for eight months, was nearly doubled.

The scientific objective of the Viking satellite was to study the ionespheric and magnetospheric phenomena at high geomagnetic latitudes in the altitude region up to about two Earth radii. Simultaneous measurements were made of electric and magnetic fields, particle distribution, plasma composition and waves as well as imaging in the ultraviolet of the aurora below.

The instruments were supplied by the three Swedish magnetospheric groups mentioned above as well as by scientific teams in Denmark, Norway, France, the Federal Republic of Germany, Canada and the United States of America. All systems and instruments on board functioned very well.

Viking was operated from Esrange, Kiruna, in the northern part of Sweden, where the telemetry data from the satellite were received and processed on a real-time basis. Ground-based observations as well as measurements from balloons and rockets were coordinated with the Viking operation.

The scientific results have been presented to the international community in symposia and conferences.

2. Freja - Sweden's second scientific satellite

Freja is a Swedish scientific satellite designed to carry instruments for research into the aurora and other magnetospheric/ionespheric phenomena. The low-cost-design satellite was launched on 6 October 1992 on the Chinese carrier Long March 2. The project was carried out in cooperation with Germany.

The satellite weighs 214 kg in the final orbit, which will range in altitude between 600 and 1,756 km. The inclination of the orbit is 63 degrees. The scientific mission of Freja has many similarities with that of Viking. The auroral zone is the "mission target" and the satellite will carry energetic particle detectors, magnetic and electric wave experiments, electric field sensors and a UV imager. The Freja design provides a substantially higher data rate than that used on Viking.

Freja is operated from Esrange. Data are received at Esrange and at the Prince Albert Satellite Station in Canada.

3. Odin - Sweden's next satellite

A combined astronomy and aeronomy satellite mission is under study. Odin is a Swedish satellite for spectroscopic studies at submillimetre wavelengths of astronomical objects and processes in the Earth's atmosphere. Launch is planned for 1996, with an operational lifetime of two years.

4. IMPACT (Investigation of Magnetospheric Particle Acceleration and Turbulence)

This is a proposed project under study in cooperation with Germany's Max-Planck Institute for Aeronomy. Current plans envision launching IMPACT in the 1998-1999 time-frame.

5. Other satellite projects

The Institute of Space Physics at Kiruna and the Swedish Space Corporation have designed experiments for the measurement of mass and energy distribution for ions and electrons in the magnetosphere. One experiment is planned for launch within the Interball concept.

The Institute of Space Physics at Kiruna will participate with hot plasma experiments (ASPERA) in the planned project Mars-94. The Institute has also participated in the development of a particle experiment for the ESA satellite Ulysses.

Both the Kiruna and the Uppsala departments of the Institute of Space Physics and the Department of Plasma Physics at the Royal Institute of Technology in Stockholm are involved in the Cluster project in the Solar Terrestrial Science Programme, the first cornerstone in the ESA space science programme Horizon 2000.

The Stockholm Observatory and the Astronomical Institutes at Lund and Uppsala are participating with several guest investigator programmes on the International Ultraviolet Explorer (IUE) satellite, which was launched in January 1978 and is still operating.

The Stockholm Observatory is also taking an active part in the ESA satellite project Infrared Space Observatory (ISO) in the construction of an IR-camera (ISOCAM). Sweden is also participating in the ESA satellite projects Giotto, HST and Hipparcos.

B. Sounding rockets and balloons

Swedish sounding rocket and balloon launches have been carried out since 1964 from Esrange, most of them as international cooperative projects.

The Swedish sounding rocket and balloon programme is concentrated on four main areas: magnetosphere and ionesphere physics; upper atmosphere physics and chemistry; astrophysical infrared studies; and materials and fluid science in microgravity. The Swedish Space Corporation is responsible for the technical execution of the projects as well as the operation of Esrange.

The Swedish MASER (Materials Science Experiment Rockets) programme which started in 1987, offers one launch per year for experiments within material physics, fluid- and bio-science.

For projects requiring an apogee of 800-1,000 km, an Attitude Control System in addition to the S-19 boost guidance system is necessary to decrease impact dispersion. A development of this new spinning rocket attitude control system (SPINRAC) has been realized, including a successful test flight.

ESA has shown interest in microgravity experiments of long duration utilizing existing rocket hardware. The Swedish Space Corporation has prepared a comparative study on long-duration sounding rockets (LDSR) for ESA. The LDSR programme, named MAXUS, will be carried out jointly by Germany and Sweden and is based on a required payload weight of 600 kg and 14-15 minutes of microgravity. The LDSR will be equipped with a modified guidance system based partly on SPINRAC. Sweden will be responsible for the facilities at Esrange and the guidance systems.

C. Ground-based experiments

Sweden participates in the work of the EISCAT Scientific Association. The Association has installed a multistatic incoherent scatter facility in the auroral zone, comprising a system of stations at Tromsø, Norway, Kiruna, Sweden, and Sodankylä, Finland.

V. ESRANGE

Esrange is a Swedish space research range situated in northern Sweden, close to the town of Kiruna at a latitude of about 68°N. The base is managed by the Swedish Space Corporation.

Space research activities are carried out at Esrange in international cooperation using ground-based instrumentation, sounding rockets, balloons and satellites. Due to the geographical location, studies of the aurora and other high-latitude phenomena are of particular interest. The land recovery possibility makes Esrange highly suitable for all sounding rocket experiments requiring recovery, e.g., microgravity research.

Esrange has the capacity to launch most types of sounding rockets, including high-performance vehicles. The range also has extensive experience in releasing scientific balloons.

Esrange's sounding rocket and balloon activities are supported by ESA. Contributing ESA members can use the range on a marginal cost basis. Non-members of ESA are also welcome to use the facilities.

Esrange is also used in various satellite projects. A number of ground segments for the support of national and international spacecraft programmes are currently in operation or under development. The majority of the passage of polar orbiting satellites are within the coverage zone of the Esrange satellite ground stations.

A facility for the reception, recording, archiving, processing and dissemination of remote sensing satellite data was established at Esrange in 1978. The station was originally used for spacecraft in the Landsat series and operated within the framework of ESA's Earthnet programme. The station has been extended to accommodate the SPOT satellites. A separate ESA facility has been established, known as the Salmijärvi satellite ground receiving station, which is dedicated to the European Remote Sensing Satellite ERS-1 and other future satellites.

A tracking, telemetry and control (TTC) station is used to support polar satellites during the launch phase and, when in service, in their nominal orbits. The Esrange TTC station was established to support initially the Swedish Viking satellite and the French SPOT-1 satellite. The station includes a dedicated operations centre and a display-and-analysis facility for scientific data.

The ground control station for Tele-X has been constructed at Esrange.

VI. OTHER SPACE-RELATED FACILITIES AND INSTALLATIONS INCLUDING TELEMETRY AND ACQUISITION

A subsidiary of the Swedish Space Corporation, SSC Satellitbild, is situated at Kiruna. Its main tasks are to process, analyse and distribute images from the SPOT and Landsat satellites.

The Onsala Space Observatory, located on the Swedish west coast, operates radiotelescopes, chiefly for radio-astronomical observations. The newest telescope has a radome-enclosed 20 m diameter reflector with very high surface accuracy for work at millimetre wavelengths.

A joint Scandinavian/INTELSAT Earth station is located at Tanum on the west coast of Sweden.

A joint Scandinavian Earth station for the European Communication Satellite (ECS) system is located near Stockholm.

A number of HRPT and APT weather picture receiving stations are in operation.

VII. INTERNATIONAL COOPERATION

Within ESA Sweden participates in the mandatory basic and scientific programmes, in the Ariane launcher project as well as in the projects for future space transportation systems, in the Columbus programme, the telecommunications programmes in the European regional communication satellite project, the advanced systems and technology programme and the preparatory programme for future telecommunications satellites in remote sensing, including ERS-1, ERS-2 and Earthnet, and finally the microgravity programme.

Bilateral scientific cooperation between Sweden and the United States is carried out under an agreement with NASA.

Similarly, scientific cooperation is being carried out with the Russian Federation under a Memorandum of Understanding with the Intercosmos Council of the Russian Academy of Sciences.

Bilateral cooperative work on space science and applications is carried out between Sweden and France under an agreement with Centre National d'Etudes Spatiales (CNES).

Sweden and Germany have concluded Memoranda of Understanding on, inter alia, scientific cooperation in the Freja Project and in the field of hypersonic technologies/Sänger.

Memoranda of Understanding have been concluded as a basis for cooperation with Austria, Canada, India and China. Other bilateral cooperative efforts are carried out on ad hoc basis, and Sweden has had cooperative projects with Denmark, Finland, Italy, Japan, the Netherlands, Norway, Switzerland and the United Kingdom of Great Britain and Northern Ireland.

Sweden is a member of INTELSAT, EUTELSAT, INMARSAT and EUMETSAT.

VIII. OTHER ACTIVITIES

Courses

Sweden has broad experience in remote sensing and the Geographic Information System (GIS) at governmental agencies, universities and companies. It is important that this experience and know-how be made available to developing countries, where there is a need for mapping and other forms of remote sensing applications. There is thus an increasing demand for technology transfer in the form of training of personnel from developing countries.

For this purpose an International Remote Sensing Institute has been established at Kiruna. The Institute, which is still operating in its initial phase, offers courses in practical applications of remote sensing. The courses are based on the resources, inter alia, of university institutes, the

SSC Satellitbild company and the Swedish Land Survey in the area. The target groups are primarily development aid personnel and personnel from developing countries.

The Institute was involved in the United Nations Training Courses on Remote Sensing Education for Educators, which took place in Sweden in 1990 and 1992 and were hosted by the Swedish Government.

The Swedish Space Corporation, in cooperation with the Swedish National Environmental Protection Agency and the local authorities, is in the process of establishing at Kiruna a Centre for Environmental Data from Satellites. The Centre will deal with the production and management of environmental databases. It will also develop new databases and carry out surveillance activities in the environmental field.

VIET NAM

[Original: English]

As a developing country, Viet Nam considers the use of space research and application for surveying natural resources and environmental conditions for developing the national economy, one of the main targets of its development programme.

In 1980 the National Committee for Space Research and Application of Viet Nam was founded, composed of representatives from various branches of science and technology. It was assigned the task of defining the direction and programme of applying results of space research to develop the national economy.

Within the framework of the Intercosmos programme in Viet Nam, technological fields such as space physics, space biology and medicine, space meteorology, space communication and remote sensing have been developed. Among those activities, remote sensing plays an important role. In the past decade some airborne experiments by multispectral cameras, the MKF-6 and MSK-4, were carried out for data analysis to serve the national economy and the area's planning development.

With the implementation of the UNDP/FAO project on "Utilization of Remote Sensing Data for Assessment of Agricultural Resources" some equipment has been supplied for photo-interpretation and image processing. Facilities for visual interpretation techniques and a centre for automatic digital interpretation have also been set up. Some ground stations have been installed to receive cloud pictures from meteorological satellites such as GMS-3, NOAA, Meteosat, etc. Attempts are being made presently to study the dynamics of cyclones, their formation, structure and movement.

Under the sponsorship of the ESCAP/UNDP Regional Remote-Sensing Programme (RRSP) a pilot project on the analysis of remote-sensing data for the assessment of natural conditions and natural resources has been recently implemented. Its objective is to study the coastal dynamics of the rivers, including erosion, accretion and biological evaluation using Landsat and SPOT data. The results of the pilot project were presented and evaluated in the regional seminar on the application of remote-sensing techniques to coastal studies and environmental monitoring held at Hanoi from 12 to 15 September 1989.

In forestry, remote-sensing techniques have been applied to vegetation map compilation. Attempts are being made to use digital image processing techniques for monitoring the changes in forest land. Remote-sensing techniques have been used in some other fields such as soil, land use, geology, hydrology, hydrogeology, cartography, oceanography, and so on.

In the past years various organizations of Viet Nam have sent many specialists to seminars/workshops or training courses organized by RRSP and UNDP. In addition, a large number of publications produced by RRSP have also been received by many agencies in Viet Nam. These publications are the main information source available in the country on remote-sensing technology development and its application.

Nowadays Viet Nam is considering its needs in the use of remote-sensing and geographic information system (GIS) technology for solving problems of environmental management.

Viet Nam highly appreciates and supports the recommendations of the forty-eighth session of the ESCAP Commission held at Beijing in April 1992 concerning the exploration of the technological advancements of space science and remote sensing for the social and economic development of the countries of the ESCAP region and the continuation of the regional collaborative efforts in remote-sensing and GIS technologies under the aegis of ESCAP and with the financial support of UNDP.

Vietnamese scientists acknowledge with deep appreciation that Viet Nam has greatly benefited from participation in international cooperation in space research and application; they are exerting their best efforts in order for it to be strengthened.